CALIFORNIA STATE MINING BUREAU.

WILLIAM IRELAN, Jr., State Mineralogist.

NINTH ANNUAL REPORT

OF THE

STATE MINERALOGIST,

FOR THE

YEAR ENDING DECEMBER 1, 1889.

SACRAMENTO:
STATE OFFICE, : : : : : J. D. YOUNG, SUPT. STATE PRINTING.
1890.

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ERRATA.

ge 64, line 17 from top, for "chili," read "Chili."
ge 65, line 3 from top, for "sulphide," read "sulphate."
ge 65, line 4 from top, for "sub-ammoniac," read "sal-ammoniac."
ge 65, line 5 from top, for "ammonia," read "ammonium."
ge 66, line 5 from bottom, for "oxidized," read "volatilized."
ge 68, line 5 from bottom, for "turpidity," read "turbidity."
ge 68, line 22 from top, for "hausing," read "housing."
ge 70, line 14 from bottom, for "turpidity," read "turbidity."
ge 76, line 7 from bottom, for "residue," read "residual."
ge 77, line 7 from bottom, for "residue," read "residual."
ge 77, last line, between "as" and "also," insert "are."
ge 77, last line, for "operations," read "manipulations."
ge 94, line 25 from bottom, for "excentric," read "eccentric."
ge 100, line 7 from top, for "excentric," read "eccentric."
ge 112, line 18 [illegible]

Page 41, line 20 from top, for "Lichthoven," read "Richthofen."
Page 44, line 13 from top, strike out all between words "employment" and "Such."
Page 44, line 16 from top, between words "Legislature" and "wise," insert "of 1888."
Page 44, line 16 from top, for "this," read "the."
Page 46, line 30 from top, between "State" and "not," insert "and."
Page 144, line 5 from top, for "mine," read "mill."
Page 206, line 3 from top, for "spirifer," read "turritella."
Page 248, line 6 from top, for "intelligent," read "intelligence."
Page 255, line 35 from top, for "Gouach," read "Gouache."
Page 328, line 11 from top, for "this search," read "his search."

Compliments of

Wm Irelan Jr.

State Mineralogist

To his Excellency R. W. WATERMAN, *Governor of California:*

SIR: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau,' approved April 16, 1880," approved March 21, 1885.

Respectfully,

J. Z. DAVIS.
W. S. KEYES.
GEO. C. PERKINS.
W. T. GARRATT.
THOS. B. BISHOP.

SAN FRANCISCO, December 1, 1889.

REPORT OF TRUSTEES OF THE STATE MINING BUREAU.

At the last session of the State Legislature there was appropriated, for the support and maintenance of the State Mining Bureau, the sum of $100,000, to be expended under the direction of the Trustees in conjunction with the State Mineralogist. Of this amount, at least 70 per cent was to be used for "geological work in the field." (See Act approved March 14, 1889.) The Act failed to mention that the appropriation should be paid "from moneys not otherwise appropriated."

In view of this contingency, the State Controller refused to allow the first demand of the Board, therefore it became necessary to apply to the Supreme Court for a writ of mandate, which, after a full hearing, was granted on the twenty-seventh of August last past.

Pending the decision of this matter, of vital importance to the Bureau, the Board deemed it only prudent to exercise rigid economy in their expenditures, and relieved from duty every employé, with three exceptions, who were imperatively needed to look after and preserve from deterioration the very valuable collection of rocks, ores, minerals, shells, fossils, etc., belonging to the State, and exposed for public inspection in the rooms of the Museum. As a consequence, the assistants of the State Mineralogist, who, under ordinary circumstances, would have entered upon their duties in the field as soon as possible after April first, could not be secured and some of them accepted other employment.

As soon, however, as the Supreme Court had favorably answered the petition of the Board of Trustees, all haste was made to vigorously prosecute the work in the field. The State Mineralogist, with his accustomed zeal and energy, selected his assistants and, with the approval of the Board, set them at work on and immediately after September first of the current year, and his report, necessarily brief, owing to the short period when field work was possible before the rainy season, will, we trust, prove acceptable to your Excellency, the Legislature, and the general public.

The Mining Bureau is, beyond question, fulfilling a popular want, and daily growing in public favor. This, we think, is proven by the demand for the published reports of the institution. The sixth annual report of the State Mineralogist consisted of six thousand copies, where, before that time, only one third of this number was printed. In spite, however, of the increase, the edition has long since been exhausted. The seventh annual report appears to have been equally appreciated, as there now remain but few copies for general distribution. In view of these facts, by order of the Governor, an edition of ten thousand copies of the ~~sixth~~ annual report was 8
issued, and of these four fifths have already been distributed, and there are daily requests for additional copies from learned societies and practical workers. Indeed, so favorably received were some of the special articles
7 contained in the ~~sixth~~ annual report, that it was found necessary to order an additional supply printed in pamphlet form.

The Trustees, in a word, congratulate the State Mineralogist that his reports do not flag in interest and are fully appreciated, not only by the

learned societies with whom we exchange, but also by the mechanics, miners, and other artisans, for whom, as comrades of "the army of industry," these publications are primarily intended.

During the past year very nearly one thousand specimens of rocks, ores, earths, etc., have been submitted to the Bureau for determination, and the senders have been promptly notified of the results in all cases where it would appear to be a matter of public interest.

The Bureau does not undertake to compete with private enterprise and does not make assays nor analyses for the benefit of private individuals.

THE MUSEUM.

The Museum has, during the past year, been enriched by the addition of over one thousand five hundred specimens, which have been classified and placed on exhibition. Twenty-six flat and three large wall cases have been constructed and filled, and the rooms are fast becoming too crowded for a proper display of our very valuable collections. The assistants in the field have obtained and forwarded many rare and interesting specimens, and the President of the Board, J. Z. Davis, Esq., has placed on exhibition a very complete and instructive suite of fossil and modern shells and a number of unique and very costly bronzes.

VISITORS TO THE MUSEUM.

From October 1, 1888, to October 1, 1889, the Museum of the Bureau was visited by throngs of resident citizens and sojourning strangers, of whom over nineteen thousand signed the register, while an uncounted but very large number failed to signify in this manner their appearance at the rooms.

FACILITIES FOR RECEIVING SPECIMENS.

Wells, Fargo & Co.'s Express continues to forward to the Bureau, free of charge, any package or packages weighing less than twenty pounds, which may be intrusted to their care in any parts of the States and Territories of the Pacific slope.

The Pacific Coast Steamship Co. has, during the past year, similarly favored the Bureau, and the Trustees gladly acknowledge the courtesy of both incorporations.

List of Donors to the Museum from October 1, 1888, to October 1, 1889.

Aaron, C. H.
Abbott, A.
Abrams, J. D.
Adams, H. C.
Adams, W.
Adams & Nichols.
Addis, J. M.
Allen, Chas. R.
American Bridge and Building Company.
Andrews, Col. A.
Armstrong, W. T.
Arnheim, J.
Atkins, R. D.
Attwood, M.
Austin, F. B.

Baranoffsky, General.
Barcroft, Fred.
Barstow, C. B.
Bartlett, A. L.
Barton, H. J.
Beckett, J. F.
Blanc, A.
Blake, Dr. Gorham.
Blake, Prof. Wm. P.
Blanding, Louis.
Billings, Geo. A.
Bingham, C. B.
Böhmer, H. S.
Bonanza Gold Mining Co., Sonora, Tuolumne County.
Boomer, Paul C.
Bowers, Stephen.
Bowers, W. O.
Bowman, C.
Brady, E. O.
Braverman, M.
Brewery Gold Mining Co.
Brian, J. W.
Bronson, Chas.
Brothers, Wm.
Brown, Prof. F. D.
Brown, W. Q.
Brumagim, Miss Blanche.
Burnell, H.

Caldwell, Daniel.
Caldwell, J. M.
Centennial Gold Mining Co.
Chapin, W. C.
Chipman, Justice.
Christiansen, P.
Clark, Ezra.
Clark, N. and son.
Coffin, F. F.
Cole, E. H.
Cowles, W. N.
Cox, Joseph F.
Craib, W.

Crapo, William.
Crossman, J. H.
Curtis, J. M.

Dana, A. W.
Dart & Oliver.
Davis, J. Z.
Day, Mrs. H. H.
Delfs, M. A.
Dickinson, Thos.
Dixon, Miss.
Dolbeer & Hoff.
Donnelly, J. W.
Doyle, R. E.
Duncan, W. E.

Ellsworth, Col. A. M.
Emerson, L. G.

Fawcett, Edgar.
Faxon, J. T.
Fleming, E. C.
Finch, N. S.
Fisher, Dr.
Ford, Edward L.
Foss, J. W.
Frost, L. L.

Garvey, Richard.
Gisborn, M. T.
Goddard, Geo. H.
Gold Run Mining Company
Goodall, Perkins & Co.
Goodyear, W. A.
Graham & Reed.
Greathouse, Hon. C. R.
Green, Jno. C.
Green, J. G.
Greenwell, L. W.
Griffing, Geo.
Grimmer, C. A.
Grover, Mrs.
Groves, G. O.
Gutman, D.

Hadsell, C.
Hague, Capt. C. J.
Hamilton, C. A.
Harkness, Dr. H. W.
Harlow, E. W.
Hanauer Smelting Company.
Harney Peak Tin Mining Co.
Hatch, W. T.
Hearst, Hon. Geo.
Hemsley, J.
Hendrick, Wm.
Henly, Geo. J.
Heslewood, J. A.
Higgins, P. C.
Hill, Benj.
Hoff, J. D.
Hook, B. F.
Howard, Frank.
Howard, General O. O.
Howard, W. C.
Holmes, A. J.
Hosmer, H. L.
Hughes, D. T.
Hutchins, W.

Ingham, A. H.

Jenkins, W. W.
Jenney, Walter P.
Job, J. A.
Johnson, J. F.
Johnston, J. A.
Jones, Thos.
Jory, Jos. H.

Kenyon, E.
Kenyon, T. W.
Keyes, W. S.
Kilpatrick, A. S.
King, L. M.
Knapp, Henry R.
Knox, R. F.
Kruse & Euler.

Laidlaw, C. H.
Lake, H. W.
Lane, Dr. L. C.
Lawrence, W. J.
Lawson, John.
Lavelle, Wm.
Lee, Chas.
Lewis, L. J.
Lintner, Martin.
Little, J. A.
Livermore Stone Company.
Locke, Sam.

Madsen, A.
Maggard, Aitken.
Markson, P.
Marshall, John S.
Maslin, Hon. S. Prentiss.
Mason, Dr. Benj. F.
Maxwell, J. W.
McCaw, Arch'd B.
McCormick, John.
McDonald, Geo.
McDonald, Capt. J. M.
McDonald, James.
McEwen, Wm.
McGregor, A.
McIntyre, A.
McKillican, D. R.
McLeod, R. R.
McMurray, R.
McRacken, W. S.
McRae, Norman.
Metzger, C. L.
Miller, F. A.
Miller, R. W.
Mills, Mrs.
Mineau, John J.
Minnesota Acad'y of Science.
Mitchell, H. K.
Monroe, Donald.
Monteverde, F. E.
Morris, Elias.
Morrow, N. L.
Moses, Otho.
Mosgrove, D. L.

Need, E. C.
Nellis, J. W.
Nelson, Ole.
Newhall, H. G.
Newhouse, O.
Newman, W. L.
Newman & Wing.
Neyman, C. M.
Nichols, Dr. Geo. B.
Nisley, P. W.
North Star Gold Mining Company of Grass Valley.
North Star Gold Mining Company of Sutter Creek.
O'Gorman, J. F.
O'Riley, James.

Pacific Stone Company.
Pahl, Richard.
Paine, J. C.
Parker, James.
Payson, L. M.
Peebles, Ed. L.
Perkins, H. C.
Perry, R. D.
Porter, Dr. Thos.
Prentiss, S. R.
Preston, E. B.
Providence Gold Mining Company.
Purinton, C. P.

Querolo, J.
Quimby, T. J.

Radelfinger, Fred.
Ream, D.
Ream, Dr. R.
Reimers, Gus.
Reilly, Geo. H.
Reynolds, C. C.
Reynolds, R.
Richardson, J. B.
Richardson, Robt.
Rider, P. W.
Roberts, A. E.
Roberts, Wm.
Robinson, J. A.
Robinson, L. L.
Roby, F. M.
Roggenkamp, H.
Roseman, H.
Royal Agricultural and Commercial Soc. of Demerara.

Sacramento Ione Coal Company.
Saling, R.
Sanders, T. B.
San Pedro, M.
Sargent, Hon. B. V.
Schamp, W. H.
Schroeder & Werner.
Scott, James A.
Scott Bar Mining Company.
Seymour, E. C.
Shed, John.
Sime, S. D.
Sinton, R. H.
Silver, Lowry.
Smith, E. Everett.
Smith, O. A.
Smith, W. C.
Soderling, A.
Sonnenfeld, Samuel.
Sprague, Geo. E.
Stanley, J. P.
Stevens, W.
Stone, D. C.
Stone, J. R.
Stow, H. P.
Sweet, S. S.

Talbott, J. F.
Taylor, A. C.
Taylor, J. B.
Taylor, R. B.
Taylor, S. S.
Thompson, Jas. G.

Thwaites, Geo. H.

Vehling, Fred.

Wallace, J. T.
Ward, A. H.
Ward, C. T.
Ward, Jas. B.
Wegner, R.
Weitbrecht, Geo.
Wertheimer, M.
Weyl, J.
Wheeler, John.
White, Miss Dollie.
Whiting, H. A.
Wilbur, O. C.
Wilcomb, C. P.
Wilkins, Jas. H.
Willey, Gen. H. I.
Wolleb, T. G. E.
Woodhull, S. D.
Wooding, J. W.
Woodruff, A.
Woody, Wm.
Wores, Chas. R.

Yates, Dr. Lorenzo G.
Yount, Samuel.

THE LIBRARY.

The Library of the Bureau continues to increase. Over seven hundred books have been added during the past year, making a total of over three thousand four hundred bound volumes, besides a large number of valuable pamphlets.

Most of this gratifying increase has arisen from our system of exchange with foreign and domestic scientific bodies and institutes, supplemented by the publications of the General Government and of the several States of the Union. Only thirty-seven books have been acquired by purchase.

The space devoted to the Library is altogether inadequate, and it has been found necessary to store many volumes, which, owing to lack of case accommodation, we have been unable to properly expose. The rooms are constantly crowded with students and specialists to consult our works of reference, which we endeavor to keep abreast of modern research and investigation. Indeed, so pressed is the Bureau for room, that neither the Board of Trustees nor the State Mineralogist has been able to set apart a room for a place of meeting, nor one for our office.

A catalogue of the Library is in process of compilation. This will lighten the labors of the Librarian and materially aid the seekers after knowledge.

We have completed, as far as possible, the full series of Government imprints on subjects kindred to the aim and objects of our institution, as well as those published by the several State Geological Surveys.

The following papers continue to be sent to the State Mining Bureau free, and we appreciate the courtesy thus extended:

Amador Dispatch, Amador, California.
Arizona Gazette, Phœnix, Arizona.
Calaveras Citizen, San Andreas, California.
Crescent City News, Crescent City, California.
Daily Union, Grass Valley, California.
Exchange and Mart, Boston, Massachusetts.
Financial Mining Record, New York, New York.
Honduras Progress, Tegucigalpa, Honduras.
Inyo Independent, Independence, California.
Lower Californian, Enseñada, Lower California.
Middletown Independent, Middletown, California.
Miner and Artisan, Los Angeles, California.
Mining Industry, Denver, Colorado.
Mining Review, San Francisco, California.
Mountain Democrat, Placerville, California.
Mountain Messenger, Downieville, California.
Oakland Daily Tribune, Oakland, California.
Placer Argus, Auburn, California.
San Leandro Reporter, San Leandro, California.
Santa Ynez Argus, Santa Ynez, California.
Ventura Vidette, Ventura, California.
Visalia Delta, Visalia, California.
Weekly Star, San Francisco, California.
West American Scientist, San Diego, California.

ACCOUNTS FROM OCTOBER 1, 1888, TO OCTOBER 1, 1889.

Receipts.

Balance on hand October 1, 1888	$19,647 21	
Less difference of $444 20 between amounts reported and collected by License Department up to and including September 30, 1889	444 20	
		$19,203 01
Paid into Mining Bureau Fund		6,845 05
Appropriation		50,000 00
		$76,048 06

Disbursements.

Salary of State Mineralogist	$3,000 00	
Rent of premises	3,000 00	
Salaries of Bureau employés	6,360 00	
Salaries of geological assistants	6,624 00	
Museum and minerals	1,267 40	
Library	620 36	
Postage	762 30	
Traveling expenses	4,731 24	
Laboratory	252 52	
Clerical assistance	607 00	
Freight and express charges	267 05	
Sundries, Bureau	599 12	
Sundries, geological	83 45	
		28,174 44
Balance on hand October 1, 1889		$47,873 62

To his Excellency R. W. WATERMAN, *Governor of the State of California:*

SIR: In accordance with the provisions of an Act of the Legislature entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880, I herewith transmit my report, regretting that causes heretofore mentioned in the report of the Trustees have so greatly retarded my work and abbreviated this report.

Very respectfully,

WM. IRELAN, JR.,
State Mineralogist.

SAN FRANCISCO, December 1, 1889.

REPORT OF THE STATE MINERALOGIST.

The clear and comprehensive report submitted by the Trustees of the State Mining Bureau to his Excellency Robert Whitney Waterman, Governor of the State of California, and published elsewhere in this volume, will make the reader fully acquainted with the reasons for delay in issuing the ninth annual report, and, also, why while the document nominally covers the space of twelve months that scarcely more than two have been devoted to active operation in the field. The short period thus left the State Mineralogist in which to obtain necessary information, has, however, been utilized to the best advantage.

Outside assistants, of known ability, well equipped, were dispatched as promptly as possible, when matters were arranged at Sacramento, to the several important fields of research and observation throughout the State.

As will be found by the returns printed in the present volume, they have addressed themselves to duty with alacrity and intelligence, and the amount of original and fresh information the field assistants have gathered—unexpected, it may be added, considering the brief time allowed for work—is herewith given to the public, in full confidence that it will be found both interesting and beneficial to all parties concerned.

In this connection it will be as well to state that the Trustees, desiring to make the Bureau the highest possible source of intelligence on all subjects of geological and mineralogical interest, have encouraged the State Mineralogist in his oft expressed purpose to commence the preparation of a geological map of the State, the object and character of which are fully explained in the paper printed elsewhere by General H. I. Willey. When completed this map will be of much service, not only to the people of the State, but to a large number of scientists and others throughout the civilized world, who regard our varied and inexhaustible resources as phenomenal. It will be readily perceived the work must occupy considerable time, but its commencement at once by competent executants, will, to all thoughtful persons interested in the prosperity of California, commend itself as a proper move to make.

In concluding his prefatory remarks, the State Mineralogist deems it his duty to acknowledge the many obligations he is under to the present Board of Trustees of the State Mining Bureau, J. Z. Davis, Esq., President; Winfield Scott Keyes, Esq., Vice-President; Hon. Geo. C. Perkins, William T. Garratt, and Thomas B. Bishop, Esquires, for their earnest and enlightened coöperation.

Mr. J. Z. Davis' trusteeship is as marked with liberality as ever, and during the past year his donations have been both numerous and costly.

To Mr. Sol. Heydenfeldt, Jr. (resigned), the Bureau is indebted for his unqualified assistance and valued advice.

He is also indebted to his Excellency Governor Waterman, for many important hints and suggestions bearing upon the best interests of the State. The fact that his Excellency is practically as well as theoretically thoroughly versed in the business of mining, makes his advice all the more valuable.

The following list comprises the names of employés:

W. A. Goodyear, Chief Geologist.
E. B. Preston, Assistant Geologist.
H. I. Willey, Engineer.
John Hays Hammond, E.M., special article.
Ross E. Browne, E.M., special article.
Russel L. Dunn, E.M., special article.
W. D. Johnston, M.D., Chief Chemist.
C. A. Ogden, Ph.D., Assistant Chemist.
H. S. Durden, Curator.
Carl Schneider, Mineralogist.
J. G. Cooper, M.D., special article.
Henry De Groot, M.D., Assistant in the Field.
Dr. Stephen Bowers, special article.
James H. Crossman, Assistant in the Field.
A. H. Weber, Assistant in the Field.
S. Gumbinner, special article.
Dr. Lorenzo G. Yates, special article.
Miss Morgie Maynard, Librarian.

The State Mineralogist regrets that the limited period afforded for field operations, has necessarily prevented him from furnishing the usual review of the various mining industries of the State, for the current year.

In the early days, when mining occupied the foremost place among the then nascent industries of California, it was the practice of the principal journals of the State to devote columns to a review of the conditions, progress, and prospects of the mining business. At the close of every year elaborate articles were published on the subject; in some cases, quarterly reviews were printed. Gradually, as the production of our mines lessened, and other material interests pushed themselves into notice, these mining reviews were curtailed until they shrank to mere items, or were discontinued altogether. The Mining Bureau of the State is now left, therefore, as the only center and the best source of this desirable information for the public. It is for this reason the State Mineralogist devotes his energies to collecting facts relating to all branches of the business, sifting, analyzing, and arranging them with a view to their entire trustworthiness. It is only in this way that the Bureau can be rendered deserving of public confidence and support.

Not until last year was the State Mineralogist able to make anything like a complete review of our mines and mining operations and the constantly occurring improvements in this industry.

The volume issued for the year 1888 deals with every mining county in the State, and contains much detailed information concerning the geology, character of the ore deposits, and the vein system of our various gold-bearing belts. It is also affluent in facts regarding the mechanical methods, the processes employed in the reduction of various kinds of ores, and in the extraction of metals.

Every prominent mining property in the State in operation at the time, producing or being actively developed, is noticed—many with much particularity. The number, weight, and drop of the stamps; cost of supplies, labor, and material; the ore crushers and feeders, concentrators and amalgamators, roasters and smelters; in short, every method, appliance, process, and device brought into mining use thus far was described. In order to facilitate reference a great deal of the information is tabulated. It is not necessary, of course, to reproduce much of this data.

The "review" of 1888 will serve the miner and others interested as a book of reference for some time to come; and thus, while room will be given to information concerning new developments and processes, ampler space can be afforded in subsequent volumes to other matters affecting directly, or germane to the vast and important mining industry of our State. And this leads to the consideration of how much the marvelous prosperity of this entire country is due to mining. Every State in the Union owes this industry something; the mid-continental regions almost their very existence. Even California, with all her wealth of soil and climate, is largely indebted to the product of her mines for her present

thrift. As for the most of her neighbors, they would, but for their mineral resources, have remained a vast wilderness to this day.

The value of the gold, silver, copper, and lead turned out in the Pacific States and Territories amounted to $120,000,000 last year; the total value of all the mineral products of the country having reached the enormous sum of $538,000,000. This exceeded the output of the year before by $70,000,000, and was greater by $100,000 than the entire product of the United Kingdom, and greater than that of all Continental Europe put together.

Nor is the prevailing impression that mining investments are unprofitable, as compared with most others, at all well founded. On the contrary, statistics show the reverse to be true, mining having disbursed more money in dividends during the past thirty years than any other branch of business. Henry B. Clifford, in the New York "Tribune," makes the statement that twelve of our leading smelting companies show the largest profits of any business in America.

Of the $110,000,000 produced by the mines in the West last year, 10 per cent, it is estimated, went to pay railroad transportation, 37 per cent to mine owners, and 15 per cent to smelting works, the remaining 38 per cent having been paid out for labor. It would be difficult to find any other large industry that returned during the year 37 per cent to the investors.

Speaking of mining, we do not include in the business gambling in mining shares, any more than does the writer on wheat growing take into his calculations the transactions of speculators in that cereal.

But aside from these large profits to the smelters and investors, these revenues to railroads, and wages paid workmen, the aid mining extends to the other industries of the country must be considered, and in this respect it is hardly of secondary importance. It is a universal helper.

There are at present about thirty thousand men engaged in the various branches of mining in California.

As now employed these miners are competitors to only a limited extent with the laborers engaged in other pursuits. They are not contending with the mechanics, the farm or factory hands, or the great unskilled army of toilers, for a living. They are not raising and putting on the markets the products of the farmer, the fruit grower, or other land tiller, nor are they waging a war on any other class of workers or producers. On the contrary, they are creating a demand for the things these people fabricate and grow—they are users and consumers, not makers of what they have to sell. Take these thirty thousand men out of the mines and distribute them among these other industries, and what would be the result? The mechanic shops, the factories, and the foundries would have more applicants for work with less work to do, and so of every other mechanical pursuit in the State.

The cultivators of the land, the fruit growers, and the stock raisers would, in like manner, have their productive forces increased, their markets being at the same time in like ratio diminished. What a hardship it would be to our mechanics, laborers, and artisans were all this host of miners recalled from the mountains to divide themselves up into squads of several thousands each, and then invade our other already overburdened industries, seeking employment. What a reduction of wages, stagnation of business, and general consternation and distress would such a movement at once precipitate!

Then, too, with mining extinguished, we would be obliged to import a great many articles which we at present produce ourselves, and thus much money would go abroad which is now retained in the country. As has well

been said, any attack on legitimate mining is a two-edged sword—it c both ways, wounding those against whom its blows are directed and th who wield it.

But while the mining industry is so largely helpful to California, it is a vital to most of her neighbors. Without this resource few of them coı ever have attained to the dignity of Statehood, or even been able to ma tain a Territorial organization. Take away the Comstock ore belt with three thousand miners, its great plant, and other costly improvements, a what would there be left of western Nevada? Nor, without its mine deposits, would more than a few fertile valleys in the rest of that State e have been wrested from the occupancy of the Pah-Utes and Shoshon But that the Comstock created a demand for forest products there wou have been no great wood and lumber camps on the summit and eastern slo of the Sierras, the most of them over the line in California. But for t Comstock, instead of the great sawmills, long-extended tramways a wood flumes, there would have stood on these mountains only the primiti forests, scarcely invaded by the enterprise of man.

As a civilizer and populator of the imperial West, mining has not be awarded its full share of merit, if, indeed, it has met with proper apprec tion at the hands of our countrymen, to say nothing of the outside wor This great West, which in its maternity of States bears twins, and ev triplets, owes its wonderful fecundity mainly to its mines.

The impression widely obtains that the gold mines in California ha been depleted below the point of profitable production. Many otherw well informed persons entertain this idea. Nothing can be more erroneo As already remarked, the gold taken out has exhausted but little of c auriferous wealth, nor has the annual production heretofore much exceed what we may reasonably hope to reach and maintain in the future.

Again, it is a mistake to suppose, as many do, that the earnings of t pioneer miners were greatly in excess of those at the present day. Th were, to be sure, somewhat larger, but not in the proportion popularly l lieved.

During the era of the largest gold production in this State—say fro 1850 to 1855, inclusive—the annual output of gold averaged only abo $55,000,000. As the mining population numbered, meantime, about o hundred and fifty thousand, their individual earnings averaged bare $366 per year, not much more than the smaller population now engaged the mines are able to earn, working by no means so many days in t year as did their predecessors. Those who work for wages do nearly as w now as they ever did, all things considered. But it now requires a larg amount of both skill and capital to accomplish much in our mines th were needed in the early days—a condition of things that puts the me wage-earner and worker at a disadvantage.

With the above two factors supplied, the opportunities for making mon in both the gold and silver mines of California are really better now th they ever were before. This the history of the business during the pa decade fully demonstrates. It has, during that period, been growi steadily, and even rapidly, in all the elements of desirable investment profit, efficiency, economy, and safety—a condition that cannot fail to dr to it capital and insure the countenance of both legislators and the peop Purged of the grosser abuses that so long militated against it, its mista largely corrected and so many other gains made, there can be no dou but that mining will, from this time on, make rapid advances in this Sta It would take but little time and energy now to double the present numb of our miners, and reach a corresponding increment in our output of go

and silver. Thirty thousand additional men in the field, followed by an annual production of thirty-five or forty millions of the precious metals, would be a grand thing for California. How it would vitalize trade, encourage enterprise, and impart a healthful impetus to every interest and industry in the State! The price of labor would be advanced, idle men and idle capital would be employed; there would be improvement everywhere and in everything; in the value of agricultural lands and their products, in city property, and even in the value of money itself.

As regards the extent of our mining field, it is simply illimitable. A hundred millions of additional capital might as well be invested there as not, nor would a hundred thousand men crowd it any more than sixty thousand. Of the mineral deposits that actually exist in California, not a tithe probably has yet been discovered, nor has a much larger proportion of those already discovered been developed to a productive condition. We have made a good beginning—hardly more.

With this much premised, we proceed in succeeding pages to briefly review mining operations in California during the past year.

CALIFORNIA'S VARIETY AND DISTRIBUTION OF MINERAL WEALTH.

Remarking on the various branches of mining actively pursued in California, it may be observed that with the most of them the past has been a year of more than average prosperity. Mining in this State is not now confined, as formerly, to the production of the precious metals. While gold mining continues with us the leading branch of the business, several of the inferior metals, as well as many of the useful minerals, are now produced here in considerable quantities. Of the latter there remains still a number with which little or nothing has been yet done, though we have them of good quality and in the greatest abundance.

Besides her gold fields, the most extensive and prolific of any in the world, and silver-bearing lodes in countless numbers, California possesses the more common metals and minerals in great variety, as will be seen by referring to previous reports of the State Mineralogist. This State is amply supplied with deposits of iron, tin, lead, copper, and quicksilver; borax, salt, and soda; petroleum, natural gas, and asphaltum; gypsum, steatite, graphite, manganese, and chromium; and with coal, nickel, antimony, asbestos, cements, ochre, sulphur, and magnesia to a more limited extent; the plastic clays, infusorial earth, lime, and building stones, including the fissile slates, abounding in many parts of the State.

There is scarcely a county in California but possesses valuable mineral deposits of one kind or another, the wide distribution of these products being something remarkable. Of the fifty-three counties in the State fourteen make a notable production of gold and twelve of both gold and silver, there being a number of counties in which these metals in smaller quantities are turned out every year. Five counties produce more or less quicksilver; two, borax; three, salt; four, asphaltum; two, petroleum; three, copper, etc.

That these common minerals have not been more largely utilized, has been due mainly to the lack of a market, the domestic consumption of the most of them having heretofore been exceedingly limited. Being for the most part cheap commodities, but few of them would bear the cost of transportation to distant points; hence, the limited extent to which these products have been turned to practical account. With available markets, such as may soon be counted on, all this will be changed.

At the rate California is being populated, it will not be long till the number of her inhabitants will be doubled, causing a corresponding increase in the home demand for these articles. Meantime, freights will be likely to undergo such reduction as to make possible their more free shipment abroad; and thus will be brought about, in the not distant future, the establishment of many additional industries and the opening up of new sources of wealth in California.

They who suppose our energies are to be devoted wholly, or even mainly, to agricultural and manufacturing pursuits are not well advised as to either the extent or the diversified character of this branch of our natural resources, nor would they seem to quite comprehend how largely some of these low-priced metals and minerals are likely yet to supersede the use of wood as a structural material. Already our houses and factories, ships and railroads, aqueducts and street pavements, not to mention innumerable other structures, implements, and mechanisms, are composed mainly of iron, lead, copper, asphaltum, the clays, the marbles, or other building stones; wood as a fuel having already been, in good measure and in many localities, wholly displaced by coal, natural gas, and petroleum.

MINING BARELY BEGUN IN CALIFORNIA.

Were California even poor in the precious metals she would yet become a great mining State. With such wealth as this she is, in this respect, destined to be a very important factor in the financial affairs of the world.

Gold mining is with us in an embryotic state. It has not yet reached even the stage of sturdy infancy. Our true golden era rests in the future, not in the past. Our El Dorado has not yet been revealed to us. It lies buried deep in the bowels of the earth.

The placer deposits that have made for us such a name, and given to mining such impetus and eclat, were but driblets which nature, having released from their matrices, brought within our easy reach as a means of encouraging us to further efforts, and leading us on to that greater and more enduring wealth stored away in the rocky ribs of the mountains.

What is here claimed for the future of mining in California is strongly foreshadowed by what has already taken place. For several years past our annual output of bullion has more than held its sum, and but for the suppression of hydraulic mining, formerly a prolific source of production, would have shown a marked increase. That gravel washing by this method will be resumed, at least in part, we have reason to hope. It would hardly be creditable to our engineering skill should we fail to devise means and methods whereby this class of debris could be so disposed of that hydraulic operations might be largely carried on without serious detriment to other interests. Could this very desirable end be reached, the gold product of the State would at once be advanced by several millions annually.

But whether this shall occur or not, that our output of bullion is going to show rapid increment is hereafter well assured.

DEBASING THE BULLION.

In this connection it should be observed that as the bullion made in California contains but a small percentage of lead and copper, the State is placed at a disadvantage when compared with certain of her neighbors, which produce these metals in large quantity, the whole being credited to them as bullion. Thus, of the large amount of bullion, $33,000,000, set down last year to Montana, more than half consisted of lead and copper;

of gold and silver she turned out but little more than California, her gold product being barely one third of ours. The same remark applies, though in less degree, to Colorado, Utah, Idaho, New Mexico, and Arizona. The bullion of Oregon, Dakota, and Washington consists almost wholly of gold; that of Nevada being composed of about 40 per cent gold and 60 per cent silver.

Apart from the injustice done California, there are, it seems to us, good reasons why this custom of classifying these base metals as bullion should be abandoned. In the first place, it is a perversion of language to so classify them, inasmuch as bullion consists of uncoined gold and silver and not of lead or copper pigs. Then, again, on the question of coinage and currency it tends to mislead. Our legislators, statisticians, and economists should not be led to suppose that these Pacific States and Territories produced last year bullion to the amount of $115,000,000, when their actual production of the precious metals was less than $90,000,000. At a time when commerce and the great industrial interests of the world are increasing at a much more rapid rate than the output of the precious metals, no intentional exaggeration of the latter should be indulged in. If this reputed output of bullion is short by $25,000,000 or more per annum, the parties who have to deal with these monetary matters ought to know it, so that they may govern their actions accordingly. It is really the case that there has for these countries been returned an aggregate of some $100,000,000 or more as bullion, that simply consisted of copper and lead. This practice, so misleading, came in with the induction of silver mining, these metals coming to be accounted bullion through their connection with silver.

In considering the bullion made in this State for the past eight or ten years, it must be borne in mind that comparatively little money has, during that period, been invested in our mines, preference having been given by capitalists to real estate, timber, railroads, and various other lines of investment. But there are, in this respect, indications of a change. With the many improvements effected it is found that mining is becoming a tolerably safe as well as a profitable industry in California. Some reverses have come, as they will come in every pursuit, yet scarcely any notable losses have here occurred in the business of late years; none, in fact, except by reason of management clearly defective, if not criminally faulty, or through investments of a purely speculative kind. But with the latter, mining has had no more to do than had the wheat growers of the State with the effort made here a few years since to control the prices of that cereal, or copper mining with the more recent operations of the French syndicate in their attempt to corner the copper markets of the world—all of which combinations resulted so disastrously to their promoters, and, in some instances, also to innocent outsiders.

As regards dealings in mining shares, these, with us, have dwindled to such small proportions that they now cause very little harm; none whatever to the business of legitimate mining. They are confined mostly to that class who are not to be restrained from hazarding some of their means in this or other forms of gambling.

NUMBER OF MEN ENGAGED IN MINING.

There has, among writers on the subject, ever existed a wide difference of opinion as to the number of men engaged in the business of mining in California, and, for that matter, in other of the Pacific States and Territories as well. H. C. Burchard, Director of the Mint, in his report for 1882, estimated the number throughout our entire mining region as follows:

Arizona	4,67
California	37,14
Colorado	28,97
Dakota	3,57
Idaho	4,70
Montana	4,81
Nevada	6,67
New Mexico	1,49
Oregon	3,68
Wyoming	35
Utah	2,59
Total	98,6

This, though much larger than the number fixed on by some, was at th time probably very nearly correct, the total in all these States and Terr tories, except California and Nevada, having been somewhat, and in mo cases, largely increased since, reaching now one hundred and forty thou sand, at least. By this is meant persons engaged directly and indirectl in mining for gold, silver, lead, and copper, there being a good many i California, with a few also in some of the other States and Territories name engaged in various other branches of mining.

Assuming that the total bullion product of these several States and Te ritories amounted this year to $120,000,000, the individual earnings of th army of men would have been $857 each.

From official returns received by the Chief of the Bureau of Statisti of Pennsylvania for 1888, it appears that the wages paid twenty thousar miners, employed at one hundred and thirty collieries, during that ye were as follows—the earnings of the best paid men amounted to ov $700, while the poorest paid reached barely $200, the average in th anthracite and bituminous regions jointly having been about $500. Th most of these men work steadily the year through.

According to official accounts the average earnings of the miners i Australia are considerably less than in California.

In apportioning the mining population among the different States an Territories, they may be assigned as follows:

Arizona	5,00
California	37,0
Colorado	35,0
Dakota	5,0
Montana	25,0
Idaho	15,0
Nevada	6,0
New Mexico	6,0
Oregon	5,0
Wyoming	1,0
Utah	6,0
Total	146,0

In the absence of any official count, there can only be claimed for the figures an approximate correctness.

It is more difficult to arrive at accuracy on this point in California tha in our other mining States and Territories, owing to the much larger nun ber of self-employers we have here, the many different kinds of mining i which they are engaged, and the manner in which they are scattered ov a great extent of territory. In these other countries mining operatio are carried on more by large companies, the number of whose employ can easily and definitely be ascertained.

Where men are employed by scores, hundreds, and even thousands, a on the Comstock range and in the big mines of Utah, Colorado, and Mo

tana, it is much less troublesome to take their census than where a like number is scattered along the "dead" and the "'live" rivers, the gulches and ravines, or throughout the hydraulic, drift, and quartz mines of California. Dispersed over such wide area, and hid away in the deep gorges and cañons, or toiling in dark pits and tunnels, a good many of these miners would be missed were even a careful enumeration of them undertaken

THE MONGOLIAN ELEMENT.

Of the entire number of California miners some ten or twelve thousand consist of Chinamen, about one third of whom are employed by the whites on wages, the balance working on their own account or for companies composed of their own countrymen.

Very few of this race engage in vein mining on their own account, nor are more than a few of them so employed by the whites, as they have a great aversion to deep underground workings.

They confine themselves mainly to the various branches of placer mining, such as working over the partially exhausted or wholly abandoned bars and gulches, reworking tailings, and in river-bed operations, the former effected by hand sluicing, the rocker also being sometimes employed, and the latter mainly by means of wing-damming.

The Chinese engage in but little drift mining, never in a large way, though some of them are employed by the white drifters, and also a few about the quartz mills.

Latterly a number of these people have betaken themselves to hydraulic mining, buying or leasing claims that have been enjoined from running. This they have done in the hope of being able to evade the mandates of the Courts, as for a time they succeeded in doing.

Recently, however, these Mongolians have about given up trying to nullify the decrees of the Courts, means having been found for defeating their efforts to that end. In the northern counties the Chinese still carry on hydraulic washing in a few places. In some cases they own the ground, though oftener it is owned by the whites, being worked under lease or on shares. The enactment of the "Exclusion Law" has tended to draw this class of foreigners away from the mineral districts, the increased demand for their services elsewhere insuring the most of them better wages than they can earn in the mines.

THE CALIFORNIA MINER.

In California the miners, more especially those engaged in placer operations, not only are self-employers to a much greater extent than is the case elsewhere, but their labors are here largely intermittent. Very few of them, except those engaged in vein or drift mining, work steadily throughout the year. The river-bed miner can prosecute his labors only in the dry season when the streams are low; other classes work to better advantage in the wet season, when water is plentiful. Only then can the so called "dry diggings" be worked or ground sluicing be carried on. Much of the hydraulic washing is also confined to this season.

Owing to this condition of things, most of our placer miners devote a portion of their time to other pursuits, such as farming, fruit and stock raising, lumbering, etc. They are apt to be land owners in a small way, nearly all of them possessing an orchard and a garden, with a few acres for grain growing and pasturage. The major portion of the gold fields are admirably adapted for grape and fruit culture.

The wages paid underground miners in this State, both vein and drift, are almost uniformly $3 per day. Millmen and other above ground hands receive from $2 50 to $2 75 per day. Chinamen, where employed, are paid about one half these rates. This is without board and lodging; when these are included the miner is charged for them at the rate of about $6 per week.

If the average earnings of the miners who work their own claims fall below the above rates, it is to be considered how much of their time is given up to other pursuits, which, besides contributing largely towards their livelihood, insure them always comfortable homes. In no other part of the world does the miner live so well nor is he so independent as in California. In comparing the annual bullion product of this with that of other countries, the above consideration should also be given due weight.

MORE COMMON MINERALS AND METALS.

Besides our output of bullion, we produce here of the economic minerals and metals values to the amount of several millions annually; far more than is produced by any one of our neighbors or perhaps by all of them put together.

These several industries, omitting the less important, give employment to some four thousand men, distributed about as follows: quicksilver, one thousand; borax, three hundred; salt, four hundred; petroleum and natural gas, asphaltum, three hundred; coal, two hundred and fifty; chromium and antimony, each fifty; slate, marble, and other stone quarries, five hundred; lime, gypsum, and the plastic clays, soda, tin, manganese, etc., one thousand.

QUARTZ MINING,

As for a long time before, continues the leading branch of the business in California. More than two thirds of the gold produced in the State, amounting now to about fourteen millions annually, being derived from this source. While the year under review has been with this class of miners a fairly good one, many of the quartz mills dependent upon water for their motive power were obliged to shut down, owing to the failure of their supply fully a month earlier than usual, causing a corresponding curtailment of bullion.

NUMBER OF QUARTZ MILLS, STAMPS, DROPS, DUTY, ETC.

We have now running in California about three thousand stamps, or their equivalent in crushing power, the number of quartz mills in operation amounting to about two hundred. These mills carry from two or three, though but few of them have less than five stamps, up to sixty each, the average of the whole being fifteen. In addition to these quartz mills, there are twenty cement mills, carrying an aggregate of one hundred stamps, their work being to crush the cement or indurated gravel taken from drift mines. In some thirty-five or forty of these quartz mills the ore is pulverized by devices other than stamps, such as the National rocker, the Huntington, Kendall, Low, Tustin, or Dodge crusher, these several machines being included according to their capacity in the foregoing enumeration of stamps.

From this list of quartz mills there have been omitted a number that may be considered useless, being worn out, or for other reasons rendered practically valueless. On the other hand, several mills in course of construction have been included therein, the work on them being so far ad-

vanced that there was reason to expect it would be completed before this report is published. For various reasons one fourth of these mills are not running; another fourth remain idle about one third of the time.

There are perhaps one hundred arrastras running in different parts of the State, some of them by water, the greater number, however, by horse or mule power. The latter crush an average of one ton, and the former two to three tons per day. These machines are employed where there is only a small amount of ore to be crushed, and which must necessarily be of good grade to justify its being worked by this slow method. The arrastra process is a favorite one with the Mexicans, in whose country it is largely adopted in both gold and silver mining.

Of our California quartz mills, about 60 per cent are run exclusively by water, 30 per cent wholly by steam, and 10 per cent by both water and steam, the latter being used when the water fails, as frequently happens toward the end of the dry season.

Attached to a few of the larger mills are chlorination works for treating the sulphurets saved by concentration, now practiced where the ore carries any considerable percentage of auriferous sulphurets, as most of the California gold-bearing quartz do.

The stamps in use with us range in weight from four hundred to one thousand pounds each. The average is about eight hundred pounds, or a little less. In former years they were much lighter than now, the tendency having been steadily towards increased weight. In only a few instances, however, have stamps been used weighing as much as one thousand pounds each. There prevails among our millmen a disposition to find something that will do not only cheaper but better work than the stamps, and many experiments with the various other machines mentioned are being made to that end. That either these or other more highly perfected devices will succeed in largely if not wholly supplanting the stamp, is not improbable. The latter has, however, succeeded in keeping its place in most of the larger mills.

We lift our stamps an averge of seven inches, and drop them from eighty-five to ninety-five times per minute; averaging ninety. Their duty amounts with us a little over two tons per day of twenty-four hours.

COST OF MINING AND MILLING ORE—VALUE AND PERCENTAGE OF SULPHURETS, ETC.

As in every mining country, the cost of ore extraction and reduction varies over a wide range in California, there being mines in this State where the cost of both operations is reduced to less than one dollar. These are, however, exceptional cases, nor are they at all numerous, the cost of mining varying here from 40 cents to $3 per ton, and the cost of milling from 39 cents to $2 per ton, the mean cost of the former being about $2, and the latter about $1 per ton. The figures here given refer to our ordinary gold-bearing quartz. There is a class of this ore so debased that the cost of its reduction is much greater than the rates above given. The expense of reducing

OUR ARGENTIFEROUS ORES

Is also greatly in excess of these rates, some of these ores requiring to be treated by roasting or smelting, though generally susceptible of reduction by simple mill or pan process.

Exclusive of the big establishments, such as the Selby and Melrose Works, designed to buy ores and to do custom work, there are not more

than a dozen smelters in the State, the most of these being located in Inyo County, only a small portion of the whole being now in operation. The silver stamp mills are included in the list of quartz mills.

HYDRAULIC MINING.

Although washing by this method has been enjoined in the central mining counties, formerly the field of its largest operations, it is, as heretofore stated, still carried on in the northwestern part of the State, chiefly in Del Norte, Trinity, Humboldt, and Siskiyou Counties. In that region there exists no objection to its being prosecuted, while the conditions for doing so are exceptionally good. Owing to scarcity of water, this class of miners harvested but a scanty gold crop last year. Their compensation came, however, later on. The early advent and great abundance of the fall rains enabled them to begin piping more than a month earlier than usual, while the heavy stock of snow on the mountains insured them an ample water supply far into the next dry season.

All included, there are in this group of counties not less than fifty hydraulic claims being operated at the present time, the most of them, however, only for a portion of the year, and in a small way. They nearly all make liberal returns for the labor employed, and the amount of money expended in fitting them up; the latter is not generally large, as lumber is cheap, and no costly bedrock tunnels are ever required, while comparatively short ditches suffice to introduce water on the ground to be washed. The auriferous gravel banks throughout this region are generally large, the material being at the same time of good grade, and free from pipe-clay and other barren matter. There is everywhere fall enough to prevent any troublesome accumulation of tailings below the washing pits, and there being no farming lands along the outletting streams liable to be injured by the debris from the mines, there is apparently no reason why hydraulic operations may not be carried on here for an indefinite period, and with large profits.

BOOMING.

It was in this section of country that the style of hydraulic mining known as "booming" was first introduced, and has since been most largely in use. It is practiced only along the gulches. These affording but little water, it became necessary that the limited supply be reservoired and properly distributed in order to make it effective in this method of gravel washing. The object is attained by retaining the water in dams and then releasing it suddenly, with a rush or boom. Near the bottom of the dam built for this purpose is left an aperture so large that when opened the water escapes rapidly. Placed on the top of the structure is a small race, through which the water flows when the dam is full, and is discharged into a large wooden box suspended from the end of the sweep, turning on a pivot, and the upper end of which extends to and over the top of the dam. Attached to this end of the sweep is a strip of heavy canvas, which, dropping in a fold over the aperture below, keeps it tightly closed when the dam is full.

When this stage has been reached the water flowing through the race into the wooden box mentioned soon fills it, causing this end of the sweep to sink and the other end to rise, carrying with it the strip of canvas and uncovering the large aperture below, allowing the water to rush out.

Meantime, the wooden box, having emptied itself through numerous small holes made for the purpose, this end of the sweep, relieved of its weight, rises, and the other end drops. The canvas falls over the outlet-

ting aperture, closing it as before. Then the dam fills again to the brim, and the operation as above is repeated. This plan for handling water is wholly automatic. It takes care of itself, and goes on day and night, without any attention on the part of the miner, doing its work as long as the water lasts. This is one of those ingenious contrivances for which the California miners have ever been noted. Since its introduction in the northwestern part of the State, it has been brought into use in many other places, some of which have presumed to claim its paternity, a distinction that unquestionably belongs to this State, where this device was originally known as the "Self-Shooter." While to us belongs the credit of this invention, to others belongs the credit of having substituted for the above name the more appropriate one by which it is now known.

DRIFT OPERATIONS.

After the elaborate and exhaustive article on drift mining, published in the last annual report of the State Mineralogist, it would be superfluous to enter here upon any extended description of the business. Confining ourselves, then, to remarking on the practical operations of the part of the year, it may be observed that they have everywhere been prosecuted with more than ordinary diligence, the developed claims having been worked successfully and some new ground opened up.

The Forest Hill Divide, Placer County, the Magalia District, in Butte County, and the vicinity of Forest City, in Sierra County, continue the most active and largely productive drift localities. A good deal is also being done in this line of mining along the Liberty Hill Ridge, about Nevada City, near Gibsonville, and at other points in western Sierra. Some very heavy operations of this kind have recently been set on foot in the latter locality.

Since the suppression of hydraulic washing in the central mining counties of the State, a number of claims before operated by that process have been worked by drifting, and, in most cases, with satisfactory results. In a few instances, however, these attempts proved so disappointing that they have been abandoned.

No very heavy drift operations are carried on in the extreme northern part of the State, nor in any of the counties south of Tuolumne, for the reason that in neither do the rich pliocene deposits occur. In the tier of counties north of Plumas and Butte, drift mining is prosecuted at a great many different points, but mostly in a limited way and along the banks of present streams or in the buried river channels of a comparatively recent date. In the regions mentioned, the claims worked in this manner are so limited in extent and their product so unimportant that they scarcely require to be individually mentioned. The working force employed is invariably small, rarely ever exceeding ten or fifteen hands, and usually about half that number.

Coming south into Butte and Plumas Counties we enter a very extensive and productive field of drift mining. The "dead rivers" here appear in great strength. The Spring Valley Company at Cherokee, Butte County, having worked their ground for many years with notable success by the hydraulic process, concluded during the past autumn to abandon that plan and adopt the drift method. The increasing depth of the superincumbent volcanic matter is the cause of this change. Surveys for the new tunnel have been completed and an estimate of the expenditure required for effecting the contemplated change also made. The expense is much less than was at first anticipated. This mine has for the past twenty-

five years, employed an average of two hundred and fifty men; its outpı gold amounted, meantime, to fully $10,000,000. To make this produc only about four thousand eight hundred linear feet of the channel inclu within the company's ground have been exhausted. Over four thous feet still remain, but this being of extra large dimensions—eight hun feet wide and nine feet thick—it is believed the remaining section, woı by the more economic drift method, will yield a total of $15,000,000. the company own over two thousand inches of water and only about t hundred inches are required for drifting, they will have a large surplu be sold for irrigation purposes. The principal drift claims worked year in this county were the Magalia, Lucretia, Bay State, Oro F Indian Springs, and Eureka, several of lesser importance having l operated in the vicinity of Little and Big Butte Creeks.

The value of the gravel extracted in Butte ranges from $1 to $5 per load; mean value, about $2. In thickness the stratum removed raı from two and one half to four feet, and in width from twenty to seve five feet—that in the Cherokee ground having the exceptional aveı thickness of nine feet and width of six hundred feet.

The number of men employed in these mines runs from five to fif the average being not above ten.

The ground is opened by tunnels, but as some of these have been ruı too high a level to effect complete drainage, the water has to be lifted to tunnel level by pumping. Nearly all the old channels in Butte are l capped, and they have to be worked by drifting, hydraulic washing b practicable in only a few localities.

Although Plumas is not largely a drift county, it contains several g claims of this class; the Sunny South and the Glazier being the ı prominent. A portion of the North America has an entrance in Sierra extends over the line into Plumas.

The Sunny South, worked by fifteen men, turned out for the year $ 000. The product of the Glazier was somewhat less. Dutch Hill, form a drift claim, has of late years been worked by the hydraulic proces costly plant having been provided for the purpose.

Coming into Sierra County, we arrive at the heart of the northern mines, with Forest City for its center. At this place two large compaı the Bald Mountain Extension and the South Fork, have been actively o ating during the past year. The North America Company, at the h of Slate Creek, have been drifting to open up new ground, of which t have large reserves supposed to be rich. The channels worked out h yielded generously for the past twenty years.

Monte Cristo and Port Wine, famous old drift camps, are likely, thro the investment of much capital in their vicinity—the most of it Englis to soon regain their former importance. Some of these new enterprises already producing handsomely, and they promise to largely increase amount in the future. Additional ground has been bonded by these other foreign companies, and it may be expected that the drift indu will at no distant day be brought into a flourishing condition along the entire Monte Cristo gravel range.

The Scotch company that last year bought possessions all along range, and on the ridge between La Porte and Gibsonville, have procee to develop their newly acquired ground with system and care. Bor are now in progress to ascertain the proper levels on which to drive t exploring tunnels. The outlook for this company is altogether encourag

THE DRIFT DEPOSITS IN NEVADA AND PLACER

Are quite as important as those found in the several counties noticed. There are several prosperous drift camps in each of these counties. In the vicinity of Red Dog and You Bet, this style of gold mining gave profitable employment to hundreds of men many years ago. The business afterwards fell into decadence, and it is now undergoing marked restoration. More than a dozen claims situated near these camps, now worked with remunerative results, lay idle until last year. Little or nothing had for a long time before been done. In other parts of the county a number of drift claims have in like manner been resuscitated and are now successfully operated for the first time in several years. The Manzanita, near Nevada City, a large and steady producer fer a decade or more, continues to turn out its usual complement of gold dust, its entire output amounting now to about $7,000,000, a portion saved by the hydraulic process. Toward the end of the year, the San José Company, a new enterprise, succeeded in getting their claim well opened and their hoisting and pumping machinery completed, and commenced gravel extraction under the most favorable circumstances. Their ground is a section of what is known as the regular blue ledge, of which there remains still fully thirty miles unworked.

The following are the leading mines now being worked on the Forest Hill Divide, the principal drift locality in Placer County: The Mayflower, Breece and Wheeler, Dardanelles, Baker Divide, Mountain Gate, Hidden Treasure, Golden River, Herman, Morning Star, Live Oak, and the Blue Wing. While these are the larger and more productive, there are several other live mines on this ridge. The big companies here employ from twenty to one hundred and fifty men each. In the neighborhood of Iowa Hill the Blue Wing and four or five other companies are taking out gravel in limited quantities, but all are making fair wages. The entire number of men employed amount to about fifty.

In El Dorado, Amador, Calaveras, and Tuolumne Counties some drift mining is carried on, Placerville and Mokelumne Hill being the most active centers of this class of mining.

Many drift claims were opened years ago, under the "table mountain" that traverses Tuolumne County, but the most of these enterprises proved unfortunate, and but little has been done there of late years.

RIVER-BED MINING—HOW CARRIED ON IN CALIFORNIA.

The object of this branch of gold mining is to recover the gravel forming the bottoms of river channels or streams, and known to be auriferous. To do this various expedients are resorted to, such as draining the channel, wholly or in part, subaqueous armor, dredging, etc. Where it is sought to drain the whole bed of the stream, the water is diverted by means of dams into a ditch or flume constructed along the bank of the stream to a point below the section to be reclaimed, and there the entire flow is returned to the channel. By this means such section can be so far freed from water that it is possible to control the seepage by pumps, wheels, etc. Where there exist natural facilities for running tunnels, the entire river-bed can in like manner be laid bare by such means. When the design is to dry and work only a strip along one side of the river-bed this is effected by what, in mining parlance, is termed a "wing-dam," that is, a water-tight wall which starts from the bank and is carried out a short distance into

and down the river, the wall being continued back to the bank. The water inside the space so inclosed is then raised with wheels or hand pumps and emptied into flumes that discharge it into the river.

The above comprise the only methods successfully employed for river-bed working in California. The trials made with dredgers, diving apparatus, etc., have proved failures alike in our river channels and in the gold-bearing sea sands along our northern coast. To a description of these dredgers, and their operations—several of which have here been undertaken—a chapter has been devoted in another part of this volume.

While not peculiar to California, river-bed mining has been pursued here on a scale not paralleled in other countries, and the efficiency of our methods greatly surpass those employed elsewhere. Outside this State the business does not appear to have reached large proportions nor has any great amount of gold been gathered elsewhere by this method.

Working the beds of the rivers that traverse the mining regions of California was begun here at an early day. The first crop of gold dust harvested by this mode, however, was very bountiful. Like some other kinds of gold mining here, this branch of the business after having prospered and attained large dimensions underwent a marked decline. It has for several years past been on the increase, however, both as regards the number and magnitude of the operations.

While workings of this kind are pursued to some extent throughout nearly all parts of our gold fields, the Klamath, Salmon, Scott, and Feather Rivers are the localities of the largest operations.

Viewed as a whole, last year proved a pretty good one for this class of miners, the rivers along which they operate having reached a very low stage early in the summer. By the first of August the most of these miners were able to commence gravel washing (some as early as the middle of July) from four to six weeks earlier than usual—a gain that was, however, to some extent, offset by the premature advent of the fall rains, which not only brought the working season to an abrupt close, but caused much damage. The high water swept away the dams, wheels, flumes, and other portions of the miners' plant. The loss thus inflicted upon the Golden Gate Company, operating on Feather River, near Oroville, amounted to over $50,000. What rendered the flooding of their claim the more vexatious was that the company had, at the time of the disaster, just commenced gravel washing, under circumstances that justified the expectation of a large clean-up, had the rain held off as long as in ordinary seasons.

This company has, no doubt, a very valuable property. It will repair its plant next summer, and proceed to work out the portion of the river channel reclaimed, nearly one mile in extent, with all possible expedition. The improvements here were made at a cost of about $100,000, but it is the opinion of competent judges that there is a million of dollars, net profit, in the claim, to be realized in the course of two or three years, should there not be a recurrence of inopportune rains.

Another enterprise of a similar character, the site of its operations being on the North Fork of the Feather River, ten miles above the town of Oroville, and eight miles above the Golden Gate claim, is known as

THE BIG BEND TUNNEL.

That this tunnel is not only the largest, but much the most costly scheme of the kind ever completed, or even projected, admits of no question. Its length is twelve thousand feet, and its size, since enlargement, thirteen feet high, with a width of sixteen feet. It lays bare thirteen miles

of the river-bed; the expenditure on the entire work amounts now to nearly a million of dollars. This tunnel, after having been completed on the original plan, being but nine feet in height, was found insufficient to carry all the water of the river, even at its lowest stage. An increase of four feet in its height was therefore necessary, the width being left as at first.

It has now capacity to carry all the water it will ever be required to take. Since the enlargement of the tunnel some gravel from the reclaimed section of the river has been worked, and yet, notwithstanding the material handled, denotes as great richness as the company had expected; operations, for reasons unexplained to the public, came to an abrupt close. More than a year has now elapsed since their suspension. When work will be resumed, if at all, we are not advised. That this abandonment is final, no one conversant with the situation believes. Many entertain the opinion that there was no need for even a temporary stoppage of work, and that suspension was ordered for purely speculative purposes. That the bed of the "Big Bend" is lacking in gold, it would be hard to make any of the old miners familiar with the history of the lower North Fork believe. This portion of the river is noted for its traditionary wealth.

THE NORTHERN TIER OF COUNTIES

Is distinguished for the many river-bed operations in progress there. The business in that section of the State is prosecuted mostly by the wing-dam system. Many of the claims are worked by the Chinese, who hold some by location, but more by purchase or under lease from the whites. Several thousand Mongolians are engaged in this class of mining in that region. For the time they are at work they make good wages. Their annual earnings are estimated to aggregate a million dollars at least. One company of these people is known to have taken, two years ago, from their claim on the Klamath below the mouth of the Scott River, over $100,000. As a rule, however, nothing definite can be learned in regard to their earnings, which are probably much larger than is generally supposed.

There are instances in which the production by some of the white companies has exceeded the above amount, though their average earnings are of course much smaller. These companies are numerous along these northern rivers. Being able to work their claims only during the summer and fall months, this class of miners turn their attention to other pursuits for the rest of the year, such as farming, lumbering, fruit growing, etc.

The following constitute the principal localities in which river-bed mining is now being carried on elsewhere in the State: Along the several forks of the Yuba, the American, and the Feather Rivers there are many small Chinese with a few larger white companies engaged in reworking the beds of these streams, the greater portions of which have been gone over and cleaned out many years ago. These river-beds have since become so much enriched through the deposit of tailings from the mines, chiefly the hydraulic washings, that they can, with the present improved gold-saving appliances, be reworked with profit.

There are here, too, some spots of virgin ground that, accidentally passed over by the pioneer miners, remain to bless the gleaners of the field.

Most of the operations along these streams, as well as at the few points further south, where any of this sort of work is being done, are carried on either by wing-damming or by diverting the water into artificial conduits along the river banks, freeing the entire channels. Recourse to tunnels for effecting the same end is had in only two or three localities.

At Horseshoe Bar, on the Middle Fork of the American River, that stream forms so nearly a loop, that a tunnel one hundred and eighty feet long, constructed two years ago, serves to drain about one mile of the river bed. At Horseshoe Bend, on the Stanislaus River, a tunnel one thousand two hundred feet in length, driven through the neck of the bend, drains the bed of that stream for a distance of two and one half miles. The Stanislaus is a considerable stream even at its lowest stage, yet this tunnel, owing to its steep grade, is capable of taking in the entire river flow, though it has a height of only seven by a width of nine feet. At both of these localities the work of gravel washing, so far as prosecuted, has proved remunerative, and this notwithstanding these sections of the river-beds so reclaimed were extensively worked in former times.

THE FUTURE OF SILVER AND ITS EFFECTS ON CALIFORNIA.

California is not, nor has she ever been a large producer of silver. Her present annual output amounts to hardly more than two millions of dollars; it has never much exceeded three millions; the total production to date is $40,000,000. It is true, we have in this State silver-bearing deposits of great extent and value. They are not only found throughout the length of our principal mining belt, but occur also in outlying districts, and, in several, constitute the dominant mineral. It is due mainly to the low prices for silver that have ruled for many years past, coupled with its uncertain future, that these deposits have not been more largely utilized. Silver was so nearly demonetized, and the course of the Government toward it so vacillating and doubtful, that our capitalists have not felt like investing in this branch of mining, which, instead of keeping abreast with our other industries, has for several years past been retrogressing.

One of our largest silver-producing companies, whose mill was destroyed by fire four years ago, determined not to rebuild it, simply because of the unsatisfactory status of this metal. As a consequence, the mine, one of the most valuable in the State, has lain idle, and will remain unworked till there be a more favorable outlook for its latent product. This is not an isolated instance.

The consideration that weighed in this case has exerted a like depressing influence on the silver-mining industry all over the world. It is more deeply felt on this coast, because labor, the chief factor of production, is here doubly dearer than in most other countries. But were California a non-producer of silver, or were she even without resources in that direction, she would none the less be the strenuous advocate of an early and complete restoration of the metal. The views of her people on all economic and industrial questions have ever been broad enough to take in the interests not only of the Pacific Coast, but of the entire country. That these interests require the rehabilitation of silver at the earliest moment practicable, is, it seems generally conceded, no longer an open question. The wonder is that, entertaining this sentiment, people should have submitted so long to silver being embargoed. What aggravates this dishonoring of the white metal is the fact that it was brought about and has since been maintained through foreign influence and for the benefit of foreign speculators in the "commodity," for such they would make it. When this conviction, only now beginning to dawn upon the public mind, becomes clearer and more distinct, it cannot fail to beget a widespread impatience with longer delay or mere half-way measures on the subject.

The history of the precious metals during the past forty years has not been creditable to the intelligence or foresight of those who have had the

direction of the world's monetary affairs. On the discovery of gold in California, followed two years later by like discoveries in Australia, these fiscal guides, fearing there would ensue an immediate and hurtful overproduction of that metal, did everything possible to work its disparagement, and gold was cheapened out of all proportion to its production. It lost, in a very short time, nearly one half its purchasing powers. In their haste to discredit it, these astute financial alarmists forgot that the population and business of the world were even then growing at a rate nearly coequal to the increment of gold. They also forgot that Mexico and South America abounded with silver mines that could readily be made to supply the apprehended relative deficiency of that metal, should it occur.

When the Comstock Mines were discovered it was a threatened glut of silver that affected these chronic alarmists, and led them to engage in a crusade against the metal, which began at once to depreciate, and has kept its downward course till, only a short time since, the lowest price on record was reached.

Ten years later, the action of Germany in compelling France to pay her enormous indemnity debt of five milliards (or five thousand millions) of francs entirely in gold, served to intensify this distrust of silver. The war waged soon after by our own Government against the white metal, dealt it another staggering blow; and all this, it will be borne in mind, without any valid reason, or even the shadow of an excuse for ostracising a money that from time immemorial had served as the principal medium of exchange, and still performs that function for more than two thirds of mankind.

When it comes to be a question of superabundance, the danger is that the repletion will be of gold rather than silver. The world's output of the former for the past decade shows a steady increase, while the yield of the latter has been falling off; the annual coinage of the United States Mints has for the past twenty years exceeded the product of the mines by more than twenty millions of dollars. For several years past silver dollars, instead of accumulating, have been diminishing in the National Treasury; and we have not more than half as much silver, per capita, as France and some other European countries can boast.

That the Council of India, sitting in London, and the creditor classes everywhere, should have favored this degradation of silver, is not to be wondered at; but that Congress, representing the largest silver-producing country on the face of the globe, should have been betrayed into a course of legislation so destructive of a great industry, and so at variance with the best interests of the whole country, is something all but inexplicable. Clearly our legislators must have been acting under a strange misapprehension of the situation. Had they studied this question of bimetallism more closely they certainly would have been impressed with the importance of extending to the business of mining for both gold and silver in this country every encouragement.

While our population is being increased at a rate that doubles it every twenty-five years, the growth of all our leading industries being in nearly the same ratio, the increment of the precious metals is comparatively slow—only about 3 per cent per annum for the past ten years. The output of our coal, copper, lead, petroleum, and most of the other useful minerals and metals has been enormously increased, our cereal crops have expanded, our flocks and herds multiplied, and railroad construction accelerated year by year; but with all this forcing ahead in other directions, mining for the precious metals has nearly stood still, and as far as the silver branch of the business is concerned, mainly because it has been crippled by unfriendly home legislation. That this American product

should have been assailed and hurt is not so intolerable, but that it shou have been "wounded in the home of its friends," seems a grievous wron and one hardly to be borne.

It must be apparent to all observant and intelligent persons that tl time has come for correcting the errors of Congressional legislation, ar repairing as far as may be the mistakes of the past. This is a point which there is hardly room for two divergent opinions. Events have tak it out of the category of debatable questions. The partial demonetiz tion of silver has cost the country, so far, about two hundred and fif millions of dollars, and it is time to call a halt. Having paid so dear for the experiment, it can hardly be expected that the country will go with it; the monometallists must, by this time, see the folly of furth opposing the restoration of silver to its former standing, because this rest is as sure to be reached as the occurrence of any event in the future. T expectation that this will soon be brought about has had a marked app ciation in the value of the metal, the price of which has advanced with the past year from 91 to 95½ cents per ounce. With free coinage at t rate of four millions of dollars per month—the maximum permissil under the present law—there is little doubt silver would soon reach p $1 29 per ounce.

It is a mistake to suppose that silver is unpopular here or anywhere e in the world. It has always and everywhere been the "money of t people," having been used as such from the earliest historic times, and now the common currency of three fourths of mankind. In the recor of our race it has earlier mention than gold. In biblical history, its mon function is spoken of at a very early date. Abraham, the patriarch, wh he bought a burial place for his family in the field of Machpelah, weigh to Ephron the "silver current with the merchants," that paid for it. T white metal from that period to the present has, in conjunction with go served as a measure of values the world over, the former having be especially favored for this purpose by Oriental people, among whom, ho ever great the production, it will always find an outlet. And it is the ca that most of the silver sent to central and eastern Asia stays the These countries open for it a market that can never be surfeited or ev satisfied. Their inhabitants, comprising more than half the population the globe, not only employ and prefer silver as their common money, b even the poorest among them use much of it for ornaments, and the wealtl have it manufactured into plate as well; all hoard it with fanatical ca Asia is a maelstrom from which silver once swept into it never retur How far can the world's annual production of silver (hardly more th $100,000,000) go towards satisfying the wants of people so multitudino after such production has been reduced by the large and constantly i creasing needs of the rest of mankind? Were the amount twice as gre as it is, it would be easily absorbed by the cravings of these countl millions of the Orient, who prefer it to gold.

A large silver circulation carries with it this further advantage: it p motes among the masses a disposition to hoard; in other words, to eco mize and treasure up this form of wealth—a practice that ought to m with every encouragement, especially among a spendthrift people like ou None of us have the same confidence in paper money that we have in hard currency.

The paper may easily be destroyed, or, through causes incidental human affairs and of frequent occurrence in the fiscal world, its value m depreciate or be lost altogether. Not so, however, with the royal meta they cannot be wholly destroyed, nor can they, under ordinary circu

stances, suffer much depreciation; hence their great fitness for storing and handling against a time of need.

As regards the treatment of silver, the United States can now safely adopt a policy of its own. Be that policy what it may, other countries will soon conform to it. From the start it might count on the concurrence of all the American republics; nor could the European Governments, in their purchases of silver, fail to become our customers. England, especially, would have to buy largely of this metal from us, as she uses many millions annually in her dealings with India.

Judging from the signs of the times, it will not be long before all Europe will adopt the bimetallic system of currency, and the probabilities are that England herself will lead the movement in this direction.

When the white metal shall have met with proper recognition, California will begin to produce it in greater quantity; the favorable indications noticeable have already imparted some additional life to silver mining in this State. With silver at par, or subjected to the same rules that govern the coinage of gold, our annual output of the metal would be doubled in a single year, and thereafter advance at a rapid rate. There is no reason why it should not, under such conditions, be increased, in the course of another decade, to ten or even twenty millions of dollars per annum, with the chance always of deposits being struck that might raise production to much higher figures.

OUR GOLD BLUFFS AND BEACHES.

Besides those already mentioned and partially described, the gold-bearing deposits of California occur in several other forms, all designated by names more or less fit, a few being perhaps a little fanciful. The most of these deposits are, in fact, distinguished not so much by any inherent peculiarities as by the conditions under which they are found and the methods and appliances adopted in working them.

The auriferous beach sands, which once afforded profitable employment to many men, have years since become so impoverished that they figure no longer among our available mineral resources. These ocean placers have, in fact, responded so feebly to the attempts made of late to work them that beach mining may be ranked among our extinct industries. But, for all this, we have these deposits of low grade in infinite quantity occurring at intervals. They reach along the seashore for many miles, extending at several points, in the form of buried channels, some distance inland. So abundant, but now so poor, these gold-bearing sands await the coming machine that is to make their further working profitable. Many machines claiming the ability to do this have already been invented and tested, but none of them have fully, or even more than partially, met the requirements of the case.

Meantime the auriferous beaches continue to be worked at a few points and in a small way. Along the seashore in Humboldt and Del Norte Counties, formerly the chief sites of this class of mining, the residents of that section of the State gather from these sands by hand sluicing a little gold every year. Their earnings are small and their labor intermittent, being prosecuted only when they have water for washing, which in most localities is the case during only a small portion of the year.

Along the shore further south some little work of this kind is also being done. Between Point Sal and Point Concepcion, off the coast of Santa Barbara, several small companies have been engaged in washing the beach sand during the past year, about twenty-five men having been so employed altogether. The employing companies, finding that white labor

at $2 per day would not pay, were obliged, in order to continue operation to engage Chinamen at half that rate. With this cheaper labor, washir at the point still goes on, it being understood, however, that the net profi realized by these companies are small. At Soquel, in Santa Cruz Count about a dozen men have been operating the past year in a manner ar with results similar to those above set forth. The foregoing compri about all that is now being done in the way of handling these beach sand The attempts made at washing them some years ago in the vicinity of Sa Francisco proved so unsatisfactory that they were after a short trial aba doned. Efforts made at a still later date to utilize deposits of this kin found in the bed of the Tia Juana River, on the southern border of Sa Diego County, have a similar history, nor has anything in this line sin been undertaken at either of the above localities.

At the locality known as "Gold Bluff" but two companies have bee operating for many years past. These are, in fact, the only parties th have ever made any large production at that point. These companies, tl Pioneer and the Union, own each four miles of the beach, which cov nearly the entire deposit lying under and constituting the workable po tion of the "bluff." The Union Company has been carrying on operatio steadily for more than twenty years, making an average annual productic of $25,000, over 30 per cent of which has consisted of net profits. For se eral years past the Pioneer Company has been doing but little, the propert having been much of the time bonded to parties who were seeking negotiate a sale of it. The death of the sole owner not long since was cause of prolonging this state of inaction. Connected with this property an important water franchise, which affords means for hydraulic washir and adds much to its value.

Besides these "gold bluffs" and "beaches," we have in California variety of other auriferous deposits, some of which, like the gold bluffs, a peculiar to the State; nor do more than a few of the others meet elsewhe with such large development as here. The principal of these deposit designating them by the local names, consist of the following, viz.:

THE DRY AND THE SEAM DIGGINGS, THE CEMENT, POCKET, AND TAILIN DEPOSITS, NUGGET MINING, CREVICING, ETC.

The Dry Diggings, so called, are simply such surface placers as, beir without a sufficient natural supply of water for washing, cannot be supplie by artificial means. There are many localities of this character in Cal fornia. In cases of this kind, if the auriferous earth is not rich enough bear transportation to water, the gold is separated from it by "dry was ing," a process formerly conducted by means of the Mexican batea, sti employed in some places. By the Spanish-speaking races the batea co tinues to be exclusively used in the "dry diggings," and these people a very skillful in handling it. Latterly, dry washing machines of vario kinds have been invented, some of which are efficient; as much so, in fac as can reasonably be looked for, considering the inherent difficulty of tl work. An entirely satisfactory "dry washer" remains, however, a desi eratum. There are in this State extensive deposits for the working which the "dry washer" alone is adapted, but these remain little utilize owing to lack of a more effective machine of this kind. These deposi occur mostly on the Mojave and the Colorado deserts. Some are met wit also, in Los Angeles and San Diego Counties. When found further nor they are situated, for the most part, in small gulches and flats, often considerable altitudes.

The Seam Diggings consist of narrow veins of auriferous quartz, varying from not more than half an inch to an inch or two in thickness, found in this State occasionally traversing other formations, and which but for their extreme richness would not justify the expense attendant on extraction. Carrying so much gold as they do, the working of these veins has generally proved remunerative. The weak point about these "razor blade" veins, as they are called, is their unreliable character; seldom do they extend to any great depth, nor does their wealth of gold always run with their downward continuity.

The best paying deposits of this kind were found some years ago in Greenwood Valley, El Dorado County. They yielded largely for a time, but are now pretty well worked out. In the South Fork District, Shasta County, occur many of these narrow veins, their average thickness being about three inches. They are not so rich, but they go deeper here, more generally than has elsewhere been the case, some of them carrying their usual quantity of gold, and holding it for forty or fifty feet before the inclosing granite pinches them out. In this locality the ore taken out is worked in arrastras; there have for many years been five or six of them running in the district, earning for the owners very fair, and, occasionally, large wages. These machines are driven by water, and crush from two to three tons of ore per day. As a rule, the quartz mined in the "seam diggings" is worked in hand mortars; its small quantity and great richness rendering this the most desirable method for its reduction.

The Cement Deposits are composed of the indurated gold-bearing gravel taken from the hydraulic and drift mines, mostly from the latter, and which, owing to its hardness, has to be crushed with stamps. This indurated gravel is met with more largely in the southern than in the more northerly drift mines, seventy-five of the hundred stamps employed in crushing it being in Nevada and Placer Counties. As the hydraulic washings approached bedrock more of this material was encountered, and but for the check put on this class of operations, twice as many stamps as are in use at present would probably be employed crushing cement.

"Pocket" Mining consists in the exploitation of that class of quartz lodes in which the available ore occurs mostly in the form of rich bunches or "pockets." While these bunches are apt to be much scattered, occurring only at long intervals, this is sometimes a lucrative branch of mining. Its grand chances prove very alluring to the more adventurous class of prospectors. While rich pockets have been encountered in the quartz lodes in all parts of the State, and throughout the entire history of mining, Tuolumne County has been most distinguished for deposits of this kind. From what is known as the Bonanza Claim, near the town of Sonora, there was claimed to have been taken, during the four years preceding 1882, nearly $1,000,000, all realized at small expense—not more than half a dozen laborers were employed. Since that time the claim has yielded, it is stated, with equal net profit, about as much more. Since 1852 this neighborhood has been noted for finds of this character. During that year a party of Mexicans took out on Bald Mountain, two miles north of Sonora, as much gold as would load a mule, but exactly how much was never known. Near Littletown, a few miles south of Sonora, two miners recently came upon a nest of these "chispas," and have since gathered over $100,000 worth, with more in prospect. From a claim at Don Pedro's Bar, in this county, there was taken, some years ago, the sum of $100,000, at a cost not to exceed $5,000. From the Morgan quartz claim, on Carson Hill, just over the line in Calaveras County, there was, in the early fifties, pounded out with a hand mortar and pestle, gold valued at $3,000,000.

With such results extending through so many years and scattered all over the State, it is not strange that this exploiting for pockets should be with many a favorite style of mining.

Hunting for "Nuggets" is carried on in both vein and placer deposits. The greatest success of late has been met with in the latter. During the past year Appel & Grant, working their quartz claim at Chip's Flat, Sierra County, it is recorded, took out in a few months, and with little more cost than their own labor, over $100,000 worth of nuggets, besides large quantities of rich ore not yet reduced. From the Baughart Mine, located twelve miles northwest from the town of Shasta, there was taken, several years since, a large number of nuggets which weighed over a pound each, besides many of lesser weight. From a placer claim situated on the Monte Cristo gravel range there was taken, last summer, a lot of nuggets ranging in value from $300 to $800 each. These nuggets much resembled in size and form small cobble-stones.

Crevicing means hunting after and digging out the free gold that makes lodgment in the small seams or crevices, whenever found. The implements used for the purpose are a stout knife and a scraper, supplemented, where necessary, by the pick. Though pursued to some extent in vein mining, it is more practiced in cleaning up the bedrock in hydraulic, drift, and other forms of placer mining. Rewashing the tailings discharged from the quartz, hydraulic, and other kinds of placer operations, of which such large quantities have been lodged along the outletting streams, has not yet been carried on to any great extent. There is little doubt, however, but that this waste material will yet be handled in an extensive manner and with satisfactory results, as much of it is known to contain a fair percentage of gold. Like the beach sands, these deposits await the machine that will insure their being handled on a large scale and in an economical way.

RECOVERING AURIFEROUS GRAVEL FROM SEA BEACHES AND RIVER BEDS BY MEANS OF DREDGES, SUBMARINE ARMOR, AND OTHER APPARATUS.

Dredging river beds as a method of gold gathering was undertaken at various localities on this coast in the early history of California mining. Although most of these attempts were signal failures, and in no instance was there any great success, they have frequently been repeated, generally at long intervals, both here and elsewhere on the Pacific Coast. An effort of this kind was made on the lower Yuba River, early in the fifties; a pioneer attempt, and, it may be added, a pioneer failure also in this department of gold mining. The gravel in this instance was brought to the surface with a bucket dredger of the ordinary kind by means of a machine placed on a scow moored in the river. The bed of the stream where operations were carried on was filled with sediment, there were no rocks nor heavy bowlders to interfere with the work. The dredger easily brought up the stuff in large quantities; but on being washed in the sluices placed on the scow for the purpose, it was found to carry too little gold to warrant prosecuting the work, and it was accordingly abandoned. The experimenters were out of pocket a good many thousands of dollars. They were not only disappointed in the result of their search for gold, but were left with a worthless apparatus on their hands that, originally, had cost them a great deal of money.

Another trial of the same kind, conducted by similar means, and which eventuated in the same way, was made many years later, the scene of operation this time being the shallow water off Gold Bluff. The object

was to recover and wash the auriferous sand found in great quantities near that point.

Even as early as the summer of 1849, the idea obtained that the gravel in the river beds of California was rich in gold. Attempts were made to reach and bring it to the surface by means of subaqueous armor; an apparatus of that kind was constructed and experimented with near Sutter's Mill at the time mentioned. The trial came very near costing the adventurous diver his life.

The machine is said to have been constructed at an expense of $700, and it did its work to perfection. The operator succeeded in filling without difficulty two half-barrels, taken down to hold the gold sands, with leaves and other rubbish strewn over the river bottom. The early mining history of the State abounds with stories of such trials, the outcome of which was failure.

Coming down to later times this kind of experimentation seemed to revive, though in none of the more recent trials has the practical difficulties before encountered been more than partially overcome. Two years ago an attempt was made to take up the gravel from the channel of the Stanislaus River, in Tuolumne County. The means employed were a powerful fan suction-pump, worked by a steam engine, the whole being placed on a boat moored in the river. In operating, a length of suction-pipe connected with the pump was lowered to the gravel. On starting the pump, sand and gravel, with much water, were raised and emptied into sluice-boxes placed on deck, the discharge being continuous. When necessary, divers in subaqueous suits went down to the river bottom and cleared away bowlders too large to pass through the pipe, also loosening with picks gravel too hard to be affected by the force of the pumps, although they were able to take up stones weighing seven or eight pounds. At last accounts it has been found impossible to clean up the river-bed in a satisfactory manner by this method; but it was thought the enterprise would eventually succeed.

About the same time a company was formed to dredge the channels of the Yuba and Feather Rivers with the Falcon centrifugal pump, a very powerful machine operated with a steam jet, supplemented, when necessary, by the aid of divers in subaqueous armor.

Though some progress is said to have been made in the way of preparation, this company has not yet got actually to work, nor are we advised as to what they are likely to do in the future.

That the Falcon pump will perform the work required seems probable, as its effectiveness has been established by crucial tests on western rivers.

Three years ago Dr. Roe had a dredger constructed, in some respects after the style of these already mentioned, intended to raise quartz mill tailings lodged in great quantity in the bed of the Carson River. The first machine built was for experimental purposes, and not only performed its work well, according to report, but demonstrated at the same time the great richness of the Carson River tailings in quicksilver, sulphurets, and amalgam. However this may have been, it does not appear that this experimental machine was followed by the construction of one of larger capacity, nor, so far as can be learned, did this preliminary trial result in any positive success. The present status of the enterprise is unknown.

WHAT HAS BEEN ATTEMPTED IN OTHER COUNTRIES.

While experimenting with dredgers, pumps, and divers on this coast has been attended with such indifferent success, trials made elsewhere appear, in most cases, to have reached better results. In New Zealand, for exam-

ple, operations of this kind have been carried on for fifteen years both along the interior rivers and on the sea beaches of the country; great stretches of the latter are auriferous. The success attained, as yet but partial, has been achieved only after numerous trials persisted in through the long time mentioned. During this period many machines of different styles and operated on different principles were used, such modifications being made in them as experience suggested. Some engaged in the business employed the old fashioned bucket, and some the centrifugal pump-dredge, the former being now, in many cases, supplemented by the latter. The chief inspecting engineer of the New Zealand Government expresses confidence in the ultimate success of these machines, but at the same time he is of opinion they are too small, as well as deficient in power. The appliances for separating coarse shingle from the fine sand before it goes over the washing tables have also been found insufficient. He approves, however, of the principle on which the machines are constructed, and expects they will soon be so improved as to adapt them completely to the handling of ocean-beach sands, at least; for working river-beds the simple bucket-dredge is preferred.

Those that have done the best service in New Zealand, and have been the longest in use, are of that pattern.

The Secretary of Mines (N. Z.) reports that a number of these machines have for the past six years been successfully operated on the Molyneux River; and, also, that many of the centrifugal pump dredges have for several years been doing satisfactory work on ocean-beach claims. By reason of the measurable success that has attended these various enterprises, more powerful and otherwise more effective dredges are being built in New Zealand, where this mode of gold mining would appear to have an encouraging future.

Our own people might, perhaps, be able to learn a few lessons from the New Zealanders' methods that would be of use in future exploitation of the auriferous river-beds and ocean beaches of California.

There are plenty of such places here if we had the machinery properly adapted to the work.

In various parts of South America, the conditions of the rivers would seem to be favorable for operations of this kind. A number are now in progress in that country; they have not been conducted, however, on a large scale, and only a few of them have been attended with any marked success.

The river-bed sand is brought to the surface mostly by native divers, who, by constant practice, are able to remain under water long enough to fill their bateas and even much larger vessels with the sands that carry a large percentage of fine gold.

WM. IRELAN, JR., *State Mineralogist, San Francisco, Cal.:*

DEAR SIR: In compliance with your request that I report to you relative to the geological survey now being prosecuted by you, permit me to give a brief summary of the status of past surveys, their results, the necessity for more methodical and systematic work, the scope of the present survey, the extent of completed work, and such other facts as come within the sphere of the labor of my department.

I respectfully submit that the public generally are not sufficiently informed concerning the necessity for, and great benefit of, a thorough knowledge of the geology of our country.

Geology, as defined by the eminent geologist, Professor Joseph Le Conte, is, "in a word, the history of the evolution of the earth and its inhabitants," or more fully, "the history of the earth and its inhabitants, as revealed in its structure and as interpreted by causes still in operation."

Further, Professor Le Conte says there is no science which requires for its full comprehension a general knowledge of so many other departments of science—a knowledge of mathematics, physics, chemistry, mineralogy, lithology, zoölogy, and botany—as are required to equip one for thorough geological investigation.

The impression that the study of geology is of little immediate benefit or practical use is as erroneous as it is common.

It is true that valuable minerals, and especially gold and silver, have been found in formations, in which, according to the geological knowledge of the particular period, they were not expected to occur, but it is also true that geology invariably leads to valuable discoveries and might have led to much greater but for the erroneous prejudice mentioned.

The discoveries of the copper mines of the Lake Superior District, which have yielded many millions of dollars in dividends, were the direct result of scientific research and deduction.

The prognostications of Baron Lichthoven, relative to the mines on the great Comstock Lode, proved to be correct, and the work undertaken on the basis of his views proved successful.

The actual proof of the existence of gold fields in Australia was the work of a practical gold hunter, not of a geologist, yet this discovery might have been made years before if the word of the celebrated geologist, Sir Roderick Murchison, had been taken as the probability of such fields existing in the southern continent, and Australia might in consequence have been to-day far in advance of her present development as an inchoate nation, magnificent though that development is.

The governments of the various colonies have become so fully alive to the value and importance of geological knowledge, that they have devoted a large share of the public revenue to such investigation, with the result that Victoria at least has long been far in advance of California in the matter of a geological survey, and prospectors can easily ascertain the general character of any district which they may desire to visit by an inspection of the complete geological maps in the Government offices. It is true that, in a few instances, prospects which have been condemned by persons claiming to be geologists, have afterwards proved to be valuable, but it would be unwise to hold the science of geology responsible for such errors of individuals, who may not have been competent geologists. It is not the province of geology to pronounce upon the results of individual mines or prospects, but rather to indicate the probabilities or possibilities of definite regions as to the class of valuable rocks or minerals which may be found.

For example, the geologists of Australia have observed that in those parts of the country in which the Laurentian rocks prevail the quartz veins are only auriferous, or at least "payable" within or in the vicinity of intrusive dikes, so that prospectors need not lose their time in searching elsewhere for good "stone."

The necessity for a systematic and complete geological research and surveys of all the portions of the globe on which we live is unquestioned. For centuries such work has been elaborately and exhaustively prosecuted in all the enlightened and progressive portions of the world at enormous expense. The unremitting energy employed and the large expense incurred in the geological investigations and surveys of what is designated as the Old World amply demonstrate that such results have been obtained

from the expenditures made for such research as to clearly show the in
timable advantage thereof to civilization and to science. In each Sta
and Territory of this Union, either by the General Government or by t
States, or by each, geological surveys have been more or less vigorous
carried on for a long period of years, with beneficial results proportion
to the accuracy and completeness thereof. But in this, our famed, fru
ful, and favored California, the greatest and most profitable field for su
research, geological surveys and investigations have been conducted on
in a spasmodic and incomplete manner. The geology of this State is n
complex but is greatly diversified, and a complete knowledge thereof
as necessary to the people as it is simple to obtain.

Permit me to quote the following cogent reasons for the necessity f
thorough geological research, as advanced by J. D. Whitney:

First—To furnish a basis for detailed explorations for farther deposits of metallic a mineral treasures, by limiting the field of research for the numerous prospectors alwa engaged in the search for useful ores; so that every man will be working where his lal will tell, and not throwing it away on undertakings which a comprehensive view of mode of occurrence and geological position of our economically valuable materials w show to be a mere waste of money, time, and energy.

Second—To insure permanent working and economical development of what is disc ered, by giving every one the means of knowing beforehand how his discoveries may turned to the best account, how much it will cost to open his mine, how much to red his ores, what form to give his products, and where and in what quantity they can be posed of. On subjects of this kind, we are constantly applied to for information, and always ready to advise to the best of our ability. And, if not now, we shall, as we beco more fully acquainted with all the necessary conditions, be able to render essential vice in this line, as our statements will be recognized as being based on extensive researcl and entirely disinterested; and in our final report we shall throw all possible light these subjects, so that it will not be our fault if the man about to embark in any en prise, connected with ores or mineral substances, will not find in our work someth which will materially aid him in his undertaking, or at least prevent a foolish wast money on the impracticable.

Third—We need a geological survey, in order that the resources of the State may made known to the world, under official guaranty of correctness, and in detail, so t not only our own capitalists, but those of other countries, may have opened to them field of investment, in regard to which they will be possessed of such definite informat that they may feel that they are not entering on a blind speculation when putting th money into a mine.

Fourth—We need such a survey as was contemplated by the Act under which we co menced our work, in order that the educational interests of the State may be advanced our schools, colleges, and University furnished with a scientific basis for instruction the different branches of geology and natural history, and with text-books in which t necessary information may be found as to the forms of animal and vegetable life occi ring on the Pacific Coast.

Fifth—We need a geological survey, in order to show to the world that the State is wi ing to contribute something towards the advancement of science, and that we may n be subjected to the mortification of having the rich harvest of facts which Califorr spreads out before us left ungathered, or only partially reaped, for the benefit, and by t efforts of other States and countries.

Admitting the necessity for such survey to exist, for the reasons herel
fore enumerated, allow me to give a synopsis of the history of the geolc
ical surveys of this State.

Apparently, the first exploring expedition to visit California and tre
upon the geological characteristics of the State was under Captain Ch
Wilkes, prosecuted during the years 1838–42, inclusive. The geolog
of this expedition was Mr. James D. Dana, whose published reports a
well known.

From 1840 to 1842 Duflot de Mofras made quite extensive exploratic
in California and Oregon and the Vermillion Sea, his reports having be
published in Paris in 1844.

In 1843–4 the "pathfinder," John C. Fremont, made some quite elal
rate geological explorations in California, Mr. James Hall having been t
geologist, whose report was published in the appendix of 1845.

In 1849-50 Bayard Taylor made some investigations of a geological and mineralogical nature.

The first report of the geological characteristics of California, after the discovery of gold, was a brief one to the Secretary of War, by Philip T. Tyson. Subsequently, James S. Wilson, a practical gold miner, published an article on the same subject in the "Quarterly Journal" of the Geological Society of London.

In 1853-4 the United States Government equipped an expedition to explore over a route for a railroad from the Mississippi River to the Pacific Ocean, under the orders of the War Department.

Mr. W. P. Blake was appointed mineralogist and geologist of this party and made some very accurate observations and reports of the same, relative to the geology of California, which were published as a report of the geological reconnoissance in California, etc., in 1858.

An article on the extent and geology of the gold-bearing belt was published in the "American Journal of Science," in 1860 and 1867. Professor Blake was appointed Geologist of the State Board of Agriculture in 1866.

On the fifth day of March, 1853, the California State Legislature passed a joint resolution requesting John B. Trask to furnish such information as he might possess relative to the geology of the State; the result of which was a report on the geology of the Sierra Nevada, or the California Range. On the sixth day of May of the same year, a resolution was passed authorizing further geological examinations of some parts of the Sierra Nevada and Coast Range.

Dr. Trask was appointed the first State Geologist. An eminent French geologist, Jules Marcou, visited California in 1854, and reports of his investigations were published in the "Bibliothequé Universal de Genéve," in 1855.

A third report of the State Geologist was presented in 1855. The fourth in 1856. In 1860, an Act of the Legislature, approved April twenty-first, by John G. Downey, Governor, created the office of State Geologist, by the first section of the Act. Professor J. G. Whitney was made such officer. The history of the survey of Professor Whitney is too well known to require comment here; and the Legislature of 1873-4 declined to make further appropriation for the prosecution of this survey and discontinued the same.

The publications of the Whitney survey are:

Geology, vol. 1, 1860-64.
Paleontology, vol. 1, 1864.
Paleontology, vol. 2, 1869.
Ornithology, vol. 1, 1870.
Botany, vol. 1, 1880.
Botany, vol. 2, 1880.
Contributions to American Geology, vol. 1. "Auriferous Gravels of California," 1880.
Yosemite Guide Book, 1870.

Several other publications of minor importance were issued by the survey, such as bulletins, catalogues of shells, fossils, etc.

The foregoing history evidences the unmethodical, diffuse, and limited extent of the geological surveys of the past, which were brought to a sudden termination in 1873-74 by the failure of the Legislature to make any further appropriations. Thus was a great, necessary, and economic research brought to a summary conclusion, by aid having been refused to the eminent geologist, J. D. Whitney.

Mining was the greatest and most profitable industry of this State from its infancy to a very recent period, and the mineralogical characteristics

of the geological survey most quickly inured to the benefit of the people. Mining is still an important industry of this State and should be recognized as entitled to great consideration at the hands of our law makers. Although mining has contributed enormously to the glory, prestige, and wealth of this State, in return little has been done for that industry. Large and frequent appropriations are made to promote and aid agricultural interests and pursuits, but, until recently, little in the interest of the miner, notwithstanding the fact that since 1848 there has inured to the State an average annual return of nearly thirty millions of dollars, not as a mere result of exchange in the busy marts of trade, *but a clear addition to the wealth of the world* as well as the State, wrested from the depths of the earth by the tens of thousands of patient toilers thereby afforded profitable employment, until the session of the Legislature of 1888. Such has been the history of geological surveys by this State, and such has been the treatment of the great industry, mining.

At this session of the Legislature wise counsel prevailed, and a determination to again resume and prosecute to a complete conclusion a comprehensive geological survey of this State caused the passage of the present Act.

By the terms of this Act $70,000 was to be used for geological work in the field, and to be used as a beginning for a thorough geological survey of the entire State, embracing everything properly pertaining to geological research and representation.

Owing to the magnitude and expense attending a thorough treatment of this great subject, it will be necessary to so segregate and arrange the plan of procedure as to give to the public the most important, practical, and economic data first, and, in the order of their importance, investigate and treat upon the various characteristics and departments of the geology of the State.

The general geological and mineralogical data should be first treated, such as the ages of various formations, their range and extent, the position which they occupy on the surface, and their relations to each other; also the location of each group of strata, with a determination of their geological ages and status, together with the lithological peculiarities of each. Also to delineate and define all geological characteristics upon a map in the position in which their outcrops occur upon the surface. Without an accurate map no correct or complete geological representation is possible, and as a basis for such representation a complete and accurate topographical map is absolutely necessary.

As instructed by you, I have now in process of construction a topographical map of this State on a scale of twelve miles to one inch, which will be complete and accurate in every detail, embracing the obtainable results of every topographical, geological, United States Coast and Geodetic, railroad, public, and private surveys of the past. I respectfully recommend that this topographical map, which will accompany your annual report for 1890, be published as such, and that all geological annotation and definition be made upon subsidiary sheets exactly corresponding to the topographical sheets, but containing only so much topography as may be absolutely necessary, thereby rendering more clear and distinct the defining of all geological characteristics.

As, owing to certain complications, the funds for the prosecution of geological work were not available until September of this year, it was only possible to obtain about two months' work of the assistants in the field, hence only a small amount of data has been accumulated for delineation upon the map; but inasmuch as the same can be put upon the map much

more rapidly than it can be gathered in the field, this is no disadvantage. Also, the topographical map must of necessity be nearer completion than now, before the subsidiary sheets can be prepared for the geological representation. Inasmuch as you determined to begin and have commenced the geological survey at the southern boundary of the State, and have ordered that it be continued northward, systematically, I have likewise commenced the completing of the map at the same place, and will have the work advanced with the field work from the south northward.

I have requested each assistant in the field to connect each and every geological characteristic with the nearest Government segregation survey corner, and carefully note directions and courses of same wherever practicable, in order to attain the greatest degree of accuracy possible in the delineation of each upon the maps, and find that they have thus far done so.

At present there is no correct or complete map of this State, all being defective and erroneous in so marked a degree as to render them misleading and valueless where any accuracy of information is desired. Therefore, the compilation and giving to the public of an accurate and reliable map, containing all data collectible up to the date of its publication, will be a contribution to the public of inestimable value. In addition to the topographical map as described, which can be corrected and added to from year to year, and maintained as the authentic map of its kind, the subsidiary sheets, containing the geological characteristics, will be successively completed as the work progresses, thereby giving to the public and the scientific world at large most valuable and exhaustive data in a most compact and comprehensive form.

In conclusion, permit me to submit that all intelligent peoples of the world recognize the wisdom and economy of thorough geological research and surveys. That we are woefully wanting in knowledge of this character concerning California, and should proceed as expeditiously as possible to obtain it. That to obtain this information an elaborate and systematic survey is necessary. That to properly give to the public the results of such survey a topographical and geological map is needed. And, finally, permit me to congratulate you upon having under auspicious circumstances effectually entered upon the collection of geological statistics in so methodical a manner as to guarantee most satisfactory results.

Respectfully,

HARRY I. WILLEY,
Engineer.

SAN FRANCISCO, December 31, 1889.

WILLIAM IRELAN, JR., *State Mineralogist:*

SIR: In answer to your letter, I have the following statement to make regarding my work, and the report which I have undertaken to prepare for your next annual report.

This work will consist in a detailed examination and careful survey of the drift mining districts of the Forest Hill ridge in Placer County, covering about twenty-five miles of the ancient river system.

The earlier developments in this section were confined to the more accessible portions of the ancient channel beds. The amount of gold produced has been estimated at from $25,000,000 to $30,000,000, and the greater part of the ridge still remains untouched. Many of the claims being worked out or proving unprofitable, were abandoned, and the openings have been filled

by caving, etc. Information, which it cost large sums of money to obtain, and which might have furnished a valuable guide in subsequent undertakings, was lost for want of a proper record. It has been necessary to repeat a great deal of prospect work merely to test the memory of predecessors.

Of late years a number of bolder enterprises have been started with the object of attacking the more deeply buried portions of the ancient channel system. It is difficult to obtain reliable data, and large expenditures are made in determining the location, course, and depth of the channels. It is not unusual for a company to expend $100,000 or more before determining the exact location, or even the existence of a pay channel within the boundaries of its property.

It becomes important to collect and record all available data, and connect, by careful survey, all surface exposures and underground developments while still accessible, with the ultimate view of throwing more definite light upon the relative position and characteristic features of the channels of the various periods. The subject is one of economic importance, as well as scientific interest.

It is also important to publish, for the convenience of the projector of new enterprises, the experience had in the better worked drift mines in methods of opening up the mine, extracting and working the gold-bearing gravel, etc.

I shall endeavor to make my work meet the requirements above indicated.

Accompanying my final report to you, will be a carefully prepared map showing the principal developments in the channel system of the Forest Hill divide.

Respectfully,

ROSS E. BROWNE.

Minerals found in the State, not heretofore in the Museum collection, excepting as donations from foreign sources:

ANTHRACITE. Found in Butte County, eight miles from Oroville, by Mr. E. Duncan.

ANTIMONY (native). Kern County, seven miles from Kernville and Havilah.

BISMUTHINITE, sulphuret of bismuth. Minarette Mountain, Fresno County.

BISMUTITE, hydrous carbonate of bismuth. Found in vein, Fresno County, Big Pine, and Antelope Spring, Deep Spring Valley. There is another specimen in the Museum which was found in sluicing, but the above is the first known to have been found in the State in ledge matter.

CALAMINE, silicate of zinc. Found in Cerro Gordo, Inyo County, and in San Bernardino County.

CALEDONITE, cuprous sulphate carbonate of lead. Found in the Union and St. Ygnacio Mines, Inyo County.

CELADONITE, green earth, hydrous silicate of iron and potassium. Found in San Mateo County, on the San Gregorio Ranch.

CELESTITE, sulphate of strontium. Found in San Bernardino County, near Calico, and in Death Valley.

CHLOROPAL, hydrous silicate of iron. Found in Placer County.

CHRYSOPHRASE, an apple-green chalcedony, colored by oxide of nickel. Found in beautiful green color near Visalia, Tulare County, by M. Braverman, January 6, 1888; Inyo County, Union Mine, St. Ygnacio, and others.

COLUMBITE, columbate of iron, niobite. King Creek District, Fresno County.

COQUIMBITE, white copperas neutral sulphate of iron oxide. Found in Lone Pine District, Inyo County.

FLINT, stink-quartz; silica 89, bituminous matter 10. Found in San Luis Obispo County, also in Santa Barbara County.

FLUORITE, fluorspar. Found in New Almaden (in white modified cubes), Santa Clara County. White purplish. Found in northwestern part of San Bernardino County.

FUCHSITE, cromglimer chrommia. Found two miles back on mesa from Arch Beach, Los Angeles County.

GILSONITE, a new hydrocarbon; sp. gr. 1.0505, and 1.05743 at 62° Fahrenheit. Found in Santa Barbara County, near Sisqua Post Office, on the land of Mr. Goldtree, of San Luis Obispo. Black shining luster; brittle; gives a brown powder; sticks to the pestle; burns with a fine flame, black smoke; has the odor of asphaltum; leaves no ashes; non-conductor of electricity and heat; naphtha and ether soften it only with intumescence; alcohol, mineral acids, and alkaline solutions have no effect on it; vegetable and the heavier petroleum oils at ordinary temperature soften it, and with heating unite with it; chloroform dissolves it, but spirits of turpentine dissolves and unites with it. One pound gilsonite in five pounds spirits of turpentine gently heated makes an excellent japanning varnish. Applied to metallic surfaces and then baked, becomes quite hard. The same varnish, mixed with half a pint of oil, renders some fabrics waterproof, and will be flexible when the varnish is perfectly dry.

HAUSMANNITE, black manganese, pyramidal manganese. Found near Auburn, Placer County.

HESSITE, telluride of silver. Found in Shasta County, in Sherer & Rattler Mine.

JAROSITE, sulphate of iron and potassium. Found in New Almaden quicksilver mine, Santa Clara County.

MELANTERITE, sulphate of iron. Found in Monterey and El Dorado Counties.

MESOLITE, lime and soda mesotype, silicate of alumina, lime, and soda. Found in Modoc and Lassen Counties.

MIMETITE, arseno phosphate of lead. Found in Cerro Gordo, Inyo County.

MINIUM, red oxide of lead. Found in Tulare County.

MIRABILITE, sulphate of soda. Found in San Bernardino County.

MOLYBDENITE, sulphuret of molybdena. Found in Sweetwater Range, Mono County; Fresno Flat, in Fresno County; White Mountain, Inyo County; also in San Bernardino and Tulare Counties.

NATROLITE, silicate of aluminum and sodium. Found in Peru Mining District, Los Angeles County.

ORTHITE, silicate of aluminum, cerium, iron, and calcium. Found in Santa Barbara County.

PECTOLITE, silicate of aluminum, calcium, natrium. Found near Santa Barbara, and also in Tehama County.

PHARMACOLITE (monoclinic), arsenate of lime. The specimens are peculiar, in that they contain calcite and baryta with pharmacolite in caves, and are covered more or less by erythrite. Veins of smaltite run through the rock, and there are also various black spots composed of sulphide of silver and arsenate of cobalt, in which may be seen free native silver, a combination not before found in California, and we have no information that it has ever been found in any other quarter. The samples were found in the O. K. Mine, San Gabriel Mining District, Los Angeles County, and were presented to the Mining Bureau by Mr. W. Evans, on June 25, 1889.

PHOSPHATE OF LIME. Found in Fresno County.

PROCHLORITE, hexagonal cleavage, silicate of iron, aluminum, and magnesia. Found in the Gold Bank Mine, with free gold and trace of silver, Forbestown, Butte County.

PYROMORPHITE, phosphate of lead. Found in the Rocky Glen Mine, Nevada County.

PYRRHOTITE, magnetic pyrites. From the Yuba Mine, Washington District, Nevada County.

REALGAR, red sulphate of arsenic. Found in San Bernardino and in the northwestern part of Trinity Counties.

RHODOCROMITE, rhodophylite, silicate of aluminum, chromium, iron, and magnesium. Found in Monterey, San Luis Obispo, Nevada, and Amador Counties.

SMALTITE, gray cobalt ore, arsenide of cobalt. Found in Lassen and in Los Angeles Counties.

SMITHSONITE, carbonate of zinc. Found in St. Ygnacio Mine and Union Mine in Inyo County and San Bernardino County.

SPINEL, silicate of aluminum, iron, magnesium, and calcium. Found at Gold Bluff, Humboldt County.

STROMEYERITE, sulphate of silver and copper. Found in Cerro Gordo, Inyo County.

TANTALITE, columbate of iron. Found in Calaveras County, near Milton.

TIEMANNITE, selenide of mercury. Found in Lake County, near Clear Lake.

TITANITE, silicate of titanate of calcium. Found in granite at St. Johns Quarry, San Bernardino County.

TOPAZOLITE, variety of garnet. Found in Tulare County.

TOURMALINE, silicate of boron, alumina, iron, magnesia, and sodium. Found in San Diego County as rubellite, but black in Plumas, Inyo, and Tulare Counties.

WILLEMITE, siliceous oxide of zinc. Found in the mines of Inyo County.

WOLLASTONITE, tabular spar, silicate of lime. Found in Lake County, near Glenbrook.

ZINC (native). Found near Cow Creek, Shasta County.

SANTA CLARA COUNTY.

By A. H. Weber, Assistant in the Field.

One of the earliest settlements made by the padres in Central Cali was located in the chief valley of this county.

The political boundaries need scarcely be repeated here, but it mi of interest to note the natural objects forming the boundaries of this flo ing county. On the northwest and north the line follows the course San Francisquito Creek to the bay, thence easterly along the cen Coyote Slough to the Lone Tree Creek; up this creek and then di east to the watershed between the San Joaquin Valley and region c Francisco Bay.

On the east the boundary between Santa Clara and Stanislau Merced Counties follows the devious line of this watershed to a po the southern headwaters of the San Felipe Creek, a tributary of the 1 River. The line then strikes due west across country until it strik Pajaro River, and continues down this stream to a point a short di below Sargent's. The boundary on the west has a general northwes southeast course, following the watershed of the Santa Cruz Mour beginning at the north at the head of the San Francisquito Creel thence southeasterly along the mountain tops till it finally reach point below Sargent's on the Pajaro River before mentioned.

Topographically the chief feature of the county is the great centr ley, hemmed in on the east and on the west by mountain chains fo part of the Coast Range. The Santa Clara Valley and its southern c uation, the Gilroy Valley, is but a part of the great depression, occup the north by the Bay of San Francisco.

These ranges of hills and mountains are by no means as simple a above words might indicate, but on the east as well as on the west c valley they consist of a series of parallel ridges, occasionally cut th by the various streams. Between these various ridges smaller but e ingly fertile valleys are located. Among such might be mentioned I San Gabriel, Calaveras, San Antonio, Los Animos, and numerous sr ones.

The ranges of mountains to the east of the Santa Clara Valley g ally rise higher and higher until they culminate in Mount Hamiltor thousand two hundred and nine feet in height. Red Mountain, a co uous landmark on the watershed forming the eastern boundary c county, does not reach this height by several hundred feet.

On the west the mountains rise more abruptly, though likewise fl by several lower ridges.

Such peaks as Mount Chonal, Loma Prieta, Umunhum, etc., for culminations of the Santa Cruz Range.

It might be well to state here that the Santa Cruz Mountains con quite a number of parallel ridges to the west of the watershed in Cruz County.

There are not many streams in the county. Chief among them Coyote Creek, rising near the eastern boundary in the center of the cc *thence it flows* southerly until it breaks through one range of hill

Gilroy Hot Springs; then it turns northerly until near Madrone where it again cuts its way through a range of hills and enters Santa Clara Valley and flows north past San José to the bay.
os Gatos Creek, the Guadaloupe, San Juan Cupertino Creek, and aller ones, drain the western and northern part of the county.
northeastern part the work is performed by the Arroyo Honde, ɔranches, Smith's Creek and Ysabel Creek, the Arroyo Bayo and ıeda Creek, all branches of the Alameda Creek, and entering the w Niles.
ajaro River and its branches, the Uvas Creek, the Arroyo de las he San Felipe Creek, carry off the surplus water from the south- of the county.
ecially characteristic feature of the ridges formed and developed streams, is, that while traveling southward through the Santa lley, the several ranges successively form the boundary of the From a few low knolls the hills gradually rise higher and higher, y finally form a continuous ridge, only to be supplanted by another n.
ature is more distinctly noticeable on the eastern than on the west- ɔf the valley. It is due to the general trend of the entire Coast om northwest to southeast, so that in going south the successive nt ridges of the Coast Range are either crossed or their heads

ological formations found within the limits of the county are the ıs, tertiary, and quaternary, or recent.
lineation of these several formations and their accurate plotting he work of years of unceasing labor. It has already been com- by the United States Geological Survey, as shown by their recent on of Monograph XIII: "The Geology of the Quicksilver Depos- Pacific Coast," by Geo. F. Becker.
cent or quaternary formation is made up of beds composed of the ɔf all the other strata, and fills the valley bottom. The beds, if y can be called, are of various composition, clay, blue or yellow, vel, varying from the coarsest to the finest, according to the dis- has been transported.
ıaracteristic feature of the recent formations on the eastern side of a Clara Valley is the frequent occurrence of pieces of volcanic These consist of basalt, but with as many cavities and the inter- alls so thin that the pieces readily float on the water, and are thus nto the valley by every freshet. They will be mentioned again

the quaternary is thus necessarily confined to the valleys, leaving ining territory to the other formations mentioned above, the sepa- the cretaceous and tertiary beds is complicated and rendered a problem to solve on account of the dense growth of chaparral, many a hillside with an impenetrable tangle, rendering explora- ɔst impossible. Further, by the scarcity of fossils to identify the ıen these are exposed; and last, but not least, by the intense and alteration many of the strata have undergone in the process of phism. A large number of instances of such metamorphism are in detail by Prof. Geo. F. Becker, in his publication mentioned ıd to which the reader must be referred.
ırd to the areas occupied by and the general distribution of such netamorphic rocks, they at first sight seem to be very irregularly ed over the country, but when taking into account the various

degrees of metamorphism, from the masses of serpentine representing, fo example, the fully altered strata, to the slightly changed sandstone, exhib iting such change only to the closest inspection, one cannot help bein struck by certain alternations of such highly altered and unchanged o but slightly altered strata. Thus, for example: Going east from Perry' Station, on the Southern Pacific Railroad, after crossing the Coyote Creek a low ridge of rounded hills is first reached scarcely two hundred feet i height, and consisting of beds of clay, clayey sand, and gravel. Thei components being soft and easily eroded material their rounded form fol lows by necessity. Closely abutting against this low ridge is a long con tinuous high ridge of greatly altered strata, consisting mostly of serpentin and rising to a height of nine hundred to one thousand feet. So closel does the low ridge first mentioned lie against the higher one, that at firs sight and even on casual examination the low hills seem but spurs of th high ridge. This impression is still further strengthened by the larg amount of detritus that has been washed down from the higher ridge, fil ing the gullies, and also by the lack of exposures of the strata composin the low ridge by reason of the softer material.

A closer examination at once reveals the great difference between th two ridges—the lower consisting of strata unaltered, or nearly so, whi the higher consists mainly of serpentine and similar highly altere rocks. At two points gullies had been cut by the winter rains dee enough to show the relation between the strata forming the two ridge At one the serpentine had a dip of about 25 degrees to the west, while th clay beds forming part of the low ridge were horizontal or with a slight east erly dip. At the other the same general relation was perceptible, thoug the actual contact was not exposed.

Continuing eastward over the high ridge the Los Animos is next crossed then comes a lower ridge of considerable extent, composed of but slightly altered material, again producing round hills. Then follows the high Pine Ridge, made up of more highly changed strata. Further east the differ ences are not so pronounced. There seems to be a great probability that the differences between the successive ridges may be caused by the changes produced by the folding of the strata in the general upheaval or formatio of the Coast Range. Thus that the portion of the strata forming a syn cline by the folding should be compressed and more highly altered tha another part forming the anticline.

An interesting section is exposed along the Penetencia Creek, showing the ridge to consist not of a similar fold but of a series of intricate an complicated minor folds. Very similar sections can be seen along th Mount Hamilton road and the road along Los Gatos Creek.

As stated before, a full discussion of the details of metamorphism in th Coast Range can be found in the monograph cited above.

Gradual chemical change, such as we call metamorphism, would presup pose the presence of water absorbed in the pores of the rock. An interest ing example to this point occurs at the Boca del Coyote, east of Madron Station. Here a basalt dike has broken through, running northeast an southwest. The rocks near the basalt were altered by the heat, that is the have lost the capacity of absorbing water to a great extent. These still sho their former structure with but slight changes, while the rocks farthe away that were unaffected by the heat have been completely changed.

Not alone do the many complicated folds of the strata render their recog nition and determination difficult, but a series of cross-faults has furthe so broken up the already contorted strata that the tracing of the continuit of the several beds becomes exceedingly perplexing.

The Goodrich and Stanford quarries afford excellent examples of this cross-faulting, much to the regret of the owners working them. Again, the quarries of the Guadaloupe Lime Company expose not alone a number of faults, but likewise a very interesting series of intricate folds; these are rendered more pronounced by the thin dark interstratified seams of siliceous rock.

To the west of San José, north of Congress Springs, a section might be described somewhat similar to the one given in detail above when traveling from Perry's Station eastward. Here we also find a lower outlying ridge composed of almost unaltered strata, followed to the westward by a high range of altered rocks. The blue shale found in these lower hills contains a few fossils. The material readily softens in water, and is scarcely more than consolidated blue, clayey mud, such as is plentifully found along the bay shore at present. Its shiny appearance, especially when rubbed, has repeatedly led people to imagine that it was coal. Here are also heavy beds of gravel accompanying the clay beds.

The low ridge described east of Perry's Station, as well as the one just mentioned, plainly show the cross-faulting spoken of above. Along the western side of Santa Clara Valley there seems to exist a fault which has caused the strata forming the bed of the valley to have a decided dip to the west. The reason this is especially mentioned here is the following: From the Laguna Seca on the south to the Willows, in San José, there are a series of small swamps (some during the entire year, others only in winter and spring) that form natural storage reservoirs. One of these, about three miles south of town, has just been drained by the city and county jointly.

At several places spurs from the range of hills on the western side run into the valley across this line of swamps, thus increasing the storage capacity of those above them.

From San José south there is a continuous rise in the valley from eighty feet at San José to nearly three hundred at Madrone Station.

The largest and most extensive of these swamps is the Laguna Seca, about fourteen miles south of San José, and, approximately, two hundred feet above the city. Mr. Polhemus, who owns a large ranch just south of the Laguna Seca, has sunk a large well (about ten feet square) through nineteen feet of soil and clay into a gravel bed, ascertained by boring to be about forty-five feet deep, and underlaid by clay. The amount of water obtained from this well is very large. A centrifugal pump of the largest size, running continuously at full speed, is unable to exhaust the water, but leaves fully four feet out of the ten feet usually in the well. In case this source of water is thoroughly exploited and developed, it may in time become one of the chief water supplies of the City of San José. The elevation is sufficient, and there seems to be a plentiful supply of water.

The great number of wells that have been bored in the valley have amply demonstrated the existence of a number of beds of gravel yielding copious flows of water. From San José northward to Alviso, most of these wells are artesian, that is, they overflow. This shows that the source of the water lies on higher ground further south.

The occurrence of basalt in the neighborhood of Madrone Station is as follows: A small dike runs through the hill on which Mr. Polhemus' residence is built; another has cut through the high ridge on the eastern side of the valley, about one mile north of the Coyote Creek, in a northeast and southwest direction. Basalt is likewise found at Murphy's Peak, southwest of Madrone Station.

It is an interesting fact that just here is found the watershed, sending the waters northward to the Bay of San Francisco on the one side, and southward to the Pajaro River and thence into the Bay of Monterey on the other side. The connection between the two seems pertinent, but whether the eruption of the basalt was the cause of the formation of the watershed, or whether, rather, the basalt was the result of an upheaval in this section, it is difficult to say. That such a force existed is attested by the numerous cross-faults found in many localities. This force acted in a general north and south direction, while originally the ranges were formed by forces acting east and west.

Another item which might be construed as favorable to the latter view is that just at this point the Coyote Creek has cut its way through the otherwise unbroken high ridge on the eastern side of the valley. The upheaval, however caused, produced a weakness in the continuity of the strata, thus affording erosion an excellent opportunity to cut across the ridge.

At this dike, just to the north of the Coyote Creek, a large quantity of the basaltic scoriæ, mentioned before as occurring along the course of the creek in the valley soil, are found with the basalt bowlders of the dike. Many of them are red, or reddish brown, from oxide of iron, resulting from the disintegration of the scoriæ. Large masses of the basalt forming the outcrop of the basalt show the characteristic columnar structure.

This basalt is located but two or two and one half miles from the railroad, easily accessible by a road. It is dense and hard, and cuts very fairly. It is an excellent material for paving blocks and should receive early attention, from its proximity to the railroad. Basalt likewise occurs on the upper course of Coyote Creek.

The mining industries of the county have not changed to any material extent during the past year, except in so far as the work of development at the several mines has progressed.

The agricultural interests in their many branches have monopolized the public attention to such an extent that the mineral resources of the county have been overlooked.

The first mine developed in the county was the New Almaden Quicksilver Mine. Its history has been written so often and in such detail that it is scarcely necessary to repeat it here. In addition the monograph already cited gives a detailed description of the mine and the full geology of the vicinity. During the past year the work of exploiting has been steadily pushed, though with but indifferent success in regard to the development of any large bodies of ore, and consequently the production of quicksilver has fallen below that of previous years.

The Guadaloupe Mining Company has not made any move during the past year toward the reopening of its mine. Considerable prospecting for cinnabar has been done on the eastern side of the valley along Silver Creek and adjacent streams. The prospects seem fair, but up to the present nothing of note has been found or at least become publicly known.

The Guadaloupe Lime Company has continued its operations during the past year, producing fully three hundred barrels of lime per month. A full description of their lime kiln was given in the eighth annual report of the State Mineralogist, pages 543 to 545. The quarries, as developed at present, show several grades in the limestone, varying from a black bituminous to a grayish white. One special feature of the lime has been noted and complained of by the parties using the same, that is, the quick setting of the lime when made up as mortar. This is rather a property of cement than of lime, and indicates the presence of silicates in the lime. A

close examination of the quarries reveals that the limestone is interstratified with narrow bands of chert often dark colored, and then easily separated by hand, but the limestone itself is often dark or the chert light in color, thus rendering the segregation of the chert well nigh impossible, and it thus finds its way into the kiln.

The silica thus introduced into the kiln with the lime fully accounts for the property of quick setting noticed and objected to by the consumers.

These bands of dark colored chert emphasize the intricate plications of the foldings to which the strata have been subjected, very similar to those exposed along the Penetencia Creek mentioned before. These plications render the work of quarrying the limestone more difficult and expensive on account of the large amount of surface and soil and waste material that it becomes necessary to remove.

Possibly the manufacture of cement might be advantageously commenced at this place, as the lime already has some of the properties of cement, and further materials necessary for the manufacture can be found near at hand.

The lime kiln near Los Gatos was in operation for awhile during the past year, and the local market supplied. At these limestone quarries they likewise have to contend with the interstratified chert, rendering hand picking necessary, and thus increasing the cost of production.

A good outcrop of light colored limestone is found to the north of the Azule Spring, several miles north of Saratoga.

Another very promising outcrop of limestone of good quality occurs to the northeast of the Goodrich Quarries. On the eastern side near the top of the ridge the limestone shows in considerable quantity. The locality is certainly a promising one, inasmuch as good roads are on both sides of the ridge; likewise railroads, the Almaden branch being on the west, while on the east the main line of the Southern Pacific is less than two miles away. The establishment of a lime kiln here would depend mainly on the supply of cheap fuel and upon the uniformity of the limestone and its freedom from chert. The latter condition cannot be answered without a more thorough examination of the magnitude of the deposit by means of small quarries or cuts.

BUILDING STONE.

The same quarries that were reported in operation a year ago have continued and extended their works according to the demand of the trade.

The quarries are located about seven or eight miles south southeast of San José, in the same range of hills in which the limestone just mentioned is likewise found. These quarries have been fully described in the eighth annual report, page 547.

The Goodrich Quarry is furthest south of all, about four hundred yards from the railroad (the Almaden branch of the Southern Pacific Railroad), at the mouth of a small ravine. One of those cross-faults mentioned before runs through the middle of the quarry as now opened. To the south of the fault the beds have a dip of fully 30 degrees to the north, while on the other side they incline but 10 to 15 degrees northeast. As at present exposed and worked the beds show the following thickness:

South of the fault from the bottom—

First ledge, eight and one half to nine feet thick.
Second ledge, five feet thick.
Third ledge, eight feet thick.
Fourth ledge, eight to nine feet thick.
Fifth ledge, twelve feet thick.
Sixth ledge, seven to eight feet thick.
Seventh ledge, nine feet thick.

The seams between the several ledges are all well defined, and carr more or less clay, especially between the fourth and fifth ledges. The cla averages fully two inches in thickness, greatly facilitating the working (the heavy top ledge (fifth, twelve feet thick). The seventh ledge, or to is naturally much broken, being at the surface; but the others show ver few fissures. Along the line of the fault all the beds are, of course, mucl broken. To the north of the fault six beds are exposed; their thickness i as follows, likewise beginning at the bottom:

First ledge, nine feet thick.
Second ledge, nine feet thick.
Third ledge, four feet thick.
Fourth ledge, one foot thick.
Fifth ledge, one foot thick.
Sixth ledge, ten feet thick.

The two nine-foot beds afford excellent material, while the three ledge at the surface (ten feet, one foot, one foot, respectively) are so much broke up that nearly all has to go to the dump.

There are other smaller openings around, from which blocks of ston have been taken occasionally, but the main work is concentrated on th quarry described above.

The beds near the surface are harder (from exposure) and somewha finer grained than those below.

The Stanford Quarries lie about half a mile to the north of the Goodricl Quarries, close to the railroad. They take their name from Governo Stanford, who has leased them from Mr. Goodrich to procure buildin material for the Stanford University, at Palo Alto. Fully one hundred feet vertical are exposed in these quarries. The beds are usually very thick (ten, fifteen, and twenty feet). They have a dip of about 20 degrees to the northeast. The seams separating the beds carry so little clay that, at first sight, the whole face exposed appears to be one solid bed; only on close inspection can the seams be made out and traced. On the contrary, the fissures, quite numerous here, carry considerable clay, so that the stone, instead of coming out in more or less regular blocks, is obtained in large irregularly shaped masses, entailing considerable loss of material and time needed to shape them.

The Flynn Quarry lies about one mile nearer San José, likewise close to the same railroad. The material is of the same quality as in the other quarries, and the beds are easily worked. This quarry has not been opened as largely as the others.

PETROLEUM.

Moody Gulch, five miles west of Los Gatos, in the Santa Cruz Mountains, is the only oil-producing locality in the county. Full descriptions of this locality have been given in the seventh and eighth annual reports of the State Mineralogist.

The Pyler Well, sunk a year ago, and described in the last report, has been abandoned after reaching a depth of over fourteen hundred feet, on account of the tools getting stuck and defying every effort to remove them

During the past year, Well No. 9 has been sunk to a depth of sixtee hundred feet. At a little over eight hundred feet the oil-bearing sand wa reached, from which the other wells still yielding derive their oil. At sixtee hundred feet "shell" rock was struck again with traces of oil. This "shell rock is a very hard, dense quartzose shale usually overlying the oil-bearin sands in this district. During the present autumn, Well No. 10 has bee started in the gulch.

ASPHALTUM.

The asphaltum deposits near Sargent Station, on the land of Mr. J. Sargent, have again received attention late this year, several carloads of the material having been taken out and shipped to San Francisco, probably to use as bituminous pavement.

COAL.

Coal has been reported from several localities in the county. One near Alma showed nothing but small fragments distributed through a soft sandstone. Another near Wright's Station proved to be a bed of black shale.

The coal found on Stevens Creek, and on the divide between Azule Spring and Stevens Creek, proved to be, as far as it could be examined, black shale.

Coal is likewise reported from Ysabel Creek, north of Mount Hamilton.

A deposit of plumbago has been found on Mr. Hubbard's ranch, on the eastern side of Ysabel Valley.

NATURAL GAS.

Natural gas has been found in small quantities in a number of localities in the county, particularly to the west of San José, in the Santa Cruz Mountains.

At Moody Gulch some gas is usually struck when boring the oil wells, at times sufficient to keep up steam. The occurrence of gas when piercing the tunnels of the narrow gauge railroad is well known. At several other spots in the neighborhood of Los Gatos traces of gas have at times been reported.

Although hundreds of artesian wells have been sunk in the vicinity of San José, many reaching a depth of one thousand feet, yet the failure to strike natural gas in any of them cannot be considered as absolute proof of its non-occurrence in the valley, but is only conclusive to the depth reached by these wells, and does not preclude the finding of gas at a greater depth of two thousand or three thousand feet.

GOLD AND SILVER.

Gold and silver finds have been reported from various parts of the county. These were mostly mentioned in the eighth annual report, but several have been reported since then. Several small pieces of gold quartz were picked up in the bed of the Llagas Creek by Mr. A. T. Herrman. On further search nothing more was found in the creek. Gold quartz carrying a few dollars in gold and silver has been found on Red Mountain, east of the San Anton Valley.

MANGANESE.

Manganese ore, aside from the well known huge bowlder at the mouth of the Penetencia Creek, also occurs on the north fork of the Penetencia Creek, about ten miles northeast from San José. This locality has been opened and some ore shipped, but the transportation into San José was found to be too expensive to make the enterprise a paying one.

COPPER.

Copper ore was found on the Hahn ranch and the mine worked ma years ago. Likewise some poor sulphuret ore was found and worked b tunnel near Lexington. Recently a fair prospect of copper ore, chie chrysocolla and malachite, has been found on the Laguna Seca ran about seventeen miles southeast of San José and about three miles fr Madrone Station.

CHROMITE.

Chromite has been found in a number of places in the county. T occurrence on the Hahn ranch was described in the last report. Since th a small pocket was found about half a mile south of Lexington.

On the high ridge on the east side of the valley, between Coyote a Madrone Stations, chromite has been repeatedly found as float piec recently several smaller pockets were found yielding excellent ore, but th ough prospecting will no doubt reveal larger quantities of the ore.

MAGNESITE.

This is quite a common mineral throughout the county, especially to t east and southeast of San José. The mineral occurs in the shape of sm nodules in and near serpentine. The principal occurrence of the mine is about three miles east of Madrone Station, not far from the Coyote Cre This locality is well known, and the main reason for calling attention the same is the interests these deposits present geologically.

A close examination of the magnesite, particularly the poorer quali reveals traces of the surrounding country rock, greenstones, and shal showing that the mineral was not deposited in a vein or bed, but rather large irregular masses, gradually replacing the country rock. As a pha of metamorphism this process is still continuing in a large number places, not only in this locality, but over a large area, however only on very small scale.

How were there such large masses of rock transformed into magnesi in a manner as to present solid masses of the mineral? They were beyo question formed by carbonate springs, such as abound throughout t county. The country rock, chiefly magnesian silicates, was decompose the magnesia transformed into magnesite and left in place while the sili was deposited in the shape of quartz or chalcedony veinlets close by.

It is quite possible that these springs were hot, or at least warm, as t basalt dike, spoken of before, is close at hand. Moreover, there is one but there are several deposits in this immediate neighborhood, at le three or four. Only the one on the east side of the ridge has been open showing fully one hundred tons in sight.

Several brickyards are utilizing the clay beds found in the Santa Cl Valley. There are two just south of San José, which, together with t extensive one on the narrow gauge railroad between San José and Can bell, supply not only the local demand but also ship to San Francis Another brickyard is at Mountain View.

The only pottery established in the county is Steiger's pottery, betwe San José and Santa Clara. Some clay from Ione is introduced to m with the local material which does not have quite the proper compositi The articles produced are chiefly sewer pipes, flower pots, etc.

SAN NICOLAS ISLAND.

By Dr. Stephen Bowers, Assistant in the Field.

San Nicolas Island belongs to Ventura County. It is nearly eighty miles south of the town of Ventura, the southeastern end being in latitude 33 degrees 14 minutes north, and longitude 119 degrees 25 minutes west from Greenwich.

The area is about nine miles long and four miles wide, containing 32.2 square miles, or twenty thousand six hundred and eight acres. Its longer axis is northwest by west.

What is known as Begg Rock is situated on the prolongation of the longer axis of the island, bearing northwest, and is seven miles distant. Soundings show that there is a submarine ridge connecting this rock with San Nicolas, and that it was probably once above the surface, but has been worn away by the action of the waves. Breakers extend for several miles to the westward, and also for nearly two miles on the eastern shore line of the island, indicating shallow water.

Begg Rock is bold and precipitous, rising to the height of forty or more feet, and plainly visible from San Nicolas.

There is an abundance of water on the island, but it is slightly brackish.

San Nicolas is entirely destitute of timber, but evidently has not always been so. At the present time there is not even a bush growing on it except a stunted kind of thorn, scarcely two feet high, and a few species of the tree cactus.

The surface is comparatively level, sufficiently so to till with little trouble. This cultivable land embraces about two thirds of the island's area, and much of it is apparently rich and fertile.

GEOLOGY OF THE ISLAND.

The underlying rocks are composed of sandstone, with calcite, dipping to the north. The calcite, which occurs in seams, varies from almost microscopic fineness to two or three inches in thickness, and often affords beautiful crystals. The angle of inclination of the rocks on the northern side is 15 degrees, and on the southern side about 13 degrees. Coral Harbor, located about three miles from the extreme western point, is reached by an opening in the rocks some twenty feet wide. The water in this opening is sufficiently deep to admit a schooner of twenty tons burden. Inside is a quiet little bay about sixty-five yards in diameter, now filling with sand drifting from the land; in a few years it will probably be entirely obliterated. From this point the rocks are exposed east and west for two or three miles along the shore, and extend some distance oceanward, forming a barrier against which the waves constantly beat. Here, as elsewhere along the shore-line of the island, the coarse sandrock is worn into fantastic forms.

In one place may be seen a portion of it rising to the height of eight or ten feet, presenting an appearance of the neck, breast, and body of an immense bird, forty feet long, with a hooded head, and as perfect in many respects as if fashioned by the hand of man.

Going westward from Coral Harbor, the rocks lose their angle of in nation, and become almost horizontal.

In most places I observed that the rocks along the immediate shore-l dip toward the ocean. The island presents the appearance of having b gradually emerged from the water, the force acting uniformly through every portion at the same time, and leaving the strata intact. East Coral Harbor, about half a mile from the ocean, is an exposure of r presenting a columnar structure.

I occasionally picked up fragments of mortars and pestles which l been manufactured from vesicular basalt, but I have reason to believe material had been brought from the main land. It is the same in ch acter as that found on the Conejo plateau.

Fragments of serpentine, obsidian, and soapstone were frequently fou in the shell heaps and Indian rancherias, but like the basalt, they dou less came from the same source, as I could find none *in situ* on the isla As stated above, the country rock is sandstone, some of which conta fossils. A thin stratum of comminuted or powdered shells occurs in sandstone at Coral Harbor, but they cannot be easily identified.

About one mile east of this is found a bed of pliocene fossils extend along a barranca (a deep break, worn by mountain floods or heavy rair from the ocean to near the center of the island. In one place in this rav I observed the following forms:

Acmæa mitra, Esch.
Acmæa patina, Esch.
Acmæa pelta, Esch.
Acmæa spectrum, Nutt.
Acmæa scabra, Nutt.
Acmæa persona, Esch.
Arionta gabbi, Newc.
Amphissa corrugata, Roe.
Bittium asparum, Leach.
Crepidula adunca, Sby.
Chlorostoma brunneum, Phil.
Chama exogyra, Con.
Chlorostoma pfeifferi, Roe.
Calliostoma annulatum, Mart.
Chlorostoma funebrale, Ad.
Crepidula dorsata, Brood.
Cumingia californica, Con.
Drillia inermis, Hds.
Euparypha tryoni, Newc.
Fissurella volcano, Roe.
Glyphis aspera, Esch.
Gadinia radiata, J. G. Cooper.
Haliotis cracherodii, Leach.
Hipponyx antiquatus, Lin.
Lottia gigantea, Gray.
Lacuna solidula, Mont.
Lazaria subquadrata, Carp.
Lunatia benisii, Gld.
Lucina californica, Con.
Mitra maura, Roe.
Muricidea subangulata, Stearns.
Pomaulax undosus, Wood.
Petricola carditoides, Con.
Stenoradsia magdalensis, Roe.
Strongylocentrotus drobachiensis.
Serpulorbis squamigerus, Carp.
Septifer bifurcatus, Roe.
Tapes staminea, var. ruderata, Con.
Tapes staminea, Con.

Nearly all round the island the shore-line is steep and about fifty high, from which the ground gradually rises in a sort of mesa or table la say one hundred to five hundred yards wide, and terminates in a st escarpment, which reaches an altitude of from five hundred to eight h dred feet. The high land is about seven by three miles in extent, sufficiently level to till. Much of it contains what appears to be good and ought to yield abundant crops if brought under cultivation. There but few exposures of rocks on the elevated portion of the island excep near the upper termination of the escarpment mentioned, where they h been denuded by wind and rain. In a few places the sandstone is cap with limestone bleached to chalky whiteness. Patches of small wa worn bowlders and pebbles of quartzite, porphyry, etc., are occasion met with on the table land. The escarpment is most abrupt on south side of the island, and in some cases is washed into pictures cañons. The western end of the island is exposed to westerly wi which often blow for many days without intermission; as a result

meets with many sand-dunes, with an occasional outcropping of shell heaps which have resisted the wind's force. In many places may be seen impressions or casts of roots of trees, ranging in size from coarse fibers to several inches in diameter. The loose soil and sand have been blown from around them, leaving the casts of semi-petrifactions intact. They are so hard as to sound metallic when thrown on the ground or when struck with a hard substance. In other places thousands of columns of indurated sand, ranging in height from a few inches to several feet, may be seen. At a distance they look like stumps of small trees. It is probable that at some period the island suffered from drought, causing the ground to crack, and these fissures have filled with drifting sand which, becoming compact, remained in upright columns, while the soil around them has been blown away.

ITS ZOÖLOGY.

The only animals found on San Nicolas are a small fox, a kangaroo mouse, and a diminutive sand lizard. One specimen of the last was seen. The fox is little more than half as large as the gray or silver fox of the mainland. As far as I have been able to learn, the species is confined to the Channel Islands. On this island it is very wild, and only seen occasionally, while on Santa Rosa it is noted for its absence of fear, not caring to move very far out of one's way. I judge that but few of these animals are now left on this island, as only three or four were seen by our party. This fox is named by Professor Baird Vulpus (urocyon) littoralis. Scarcely more than half the size of the gray fox (Vulpus virginianus); tail one third the length of body; above, hoary and black; sides of neck, fore legs, and lower part of sides, dull cinnamon; chin and sides of muzzle, black; tail, with a concealed mane of stiff hairs, and with black stripe above.

Their skeletons are frequently met with in the shell heaps and Indian rancherias—especially the skulls. I only saw one specimen of the kangaroo mouse. Seals, sea-lions, and other varieties of phocæ are still found here, but in limited numbers. In this connection I may speak of the remains of two species of dogs found all over the island. One of them, which seems to have resembled the bull-terrier, is probably a distinct species, and, if I mistake not, was identified by Professor Baird. It was domesticated by the Indians, and found living here as late as 1853. In some places as many as half a dozen skeletons of these canines may be seen lying together, indicating that they had perished from exposure and starvation.

Several species of land birds are found. Amongst them may be mentioned the bald eagle, ground owl, raven, crow, and plover. Water fowl are abundant, and among them are gulls, pelicans, cormorants, sea pigeons, and others.

On one occasion a continuous flock of these birds flew past our tent for the space of about three hours. There were unnumbered thousands. Beetles, crickets, spiders, butterflies, house and other flies are met with, but no poisonous or noxious animals or insects.

A noticeable feature of this island is the vast number of dead land shells strewn over the surface. There are two species of the Helix (euparypha) tryoni and Helix (arionta) gabli, the former predominating.

They are almost as numerous as the grains of sand driven before the wind, but not a living specimen is to be found. When they flourished there was vegetation on the island sufficient to support them, and their large size

and vast numbers indicate anything but the arid waste that the surf now presents.

Mr. Nidever speaks of a portion of the island covered forty years with trees, brush, and moss.

These land mollusks were collected and eaten by the Indians, as m conical piles in their rancherias would indicate.

San Nicolas Island must have once supported a large population. whatever direction one turns he comes in contact with human skelet broken mortars, pestles, ollas, bone implements, ornaments, etc., and s heaps.

The circular depressions showing where their houses once stood may be seen in great numbers. On a projecting point near the ocean I coun forty of these depressions, but not a vestige remains of the material out which their habitations were constructed. The shell heaps and rancher extend over the greater portion of the island. The one upon which pitched our tent is about six miles long, with only an occasional bre It extends around the western end of the island, averages a mile or m in width, and is of unknown depth. About one mile east of Coral Harl is a break in the shell heaps nearly half a mile in width, after which rancherias appear again and extend around the eastern end of the isla

The high land, or more central portion of the island, contain hundr of these shell heaps, forming in many instances truncated eminences. (is astonished at the vast number of shells found in these heaps. Inde it is impossible to convey to the reader anything like an adequate conc tion of their number. Millions multiplied by millions would be bu beginning. The haliotis (a genus of the Gasteropods) probably predo nates; but all kinds of mollusks that these waters afforded, with every s cies of fish which the natives could take with their rude hooks and spe seals, sea-lions, sea-elephants, whales, sea-otters, aquatic birds, as well the island fox, were used by them for food.

In very many places human skeletons may be seen. The wind removed the covering of earth and sand and left them exposed. The bo of these skeletons are large, and their processes denote great physi development, while the facial angles of the skull indicate more than o nary intelligence for Indians.

I judge that the natives of this island were physically and intellectu superior to those inhabiting the other islands and the mainland, where previous explorations, I have exhumed several thousands of skeletons.

Many of the skulls on San Nicolas resemble closely those of the Cau sian type.

The method of burial was similar to that of the other Indians in t section—with the knees drawn up against the breast and the bodies bur face downward. As artificers in bone, stone, and wood they were certai in advance of their redskinned contemporaries. This is the only place wh I found a barbed fish-spear and stone knives with wooden handles. T Indians also used bone needles, with eyes perforated at the larger end the purpose of carrying thread or sinew. As very few arrowheads, or ot implements suggesting hostilities were found on this island, the inhabita could not have been a warlike race. They doubtless lived in comparat peace among themselves, and were too remote from the other Indians a the mainland to receive attacks from those quarters.

Fragments of boat-shaped vessels, carved from crystallized talc, serp tine, sandstone, bone, etc., as well as imitations of whales and fishes, sh them to have been an imitative people; and they were probably sun w

shipers, as were the Santa Rosa Islanders; there are also indications of Phallic adoration.

They made much use of serpentine, from which they carved pipes, cups, discs, and a variety of ornaments. Their bone implements consisted of needles, perforators, scrapers, chisels, and also long bones flattened at the end, probably used for removing haliotis and limpets from the rocks.

A noted relic found on this island is the perforated disc. These discs are from one inch to five inches in diameter, and usually made of sandstone and serpentine. In most instances the hole is drilled from both sides, and is much larger on the outside than at the center. In other cases, the perforation is of the same size all the way through. Some of these discs have been highly polished. There is a variety of opinions amongst archæologists as to the use of these discs. Without entering into a discussion of this subject, I would remark that an Indian, to whom I once exhibited one of them, informed me they were used in games, which I doubt not is correct. In many places, piles of small, black pebbles are found, numbering from fifty to more than one hundred. In some instances they are carefully packed in large haliotis shells, and carefully covered with the same. It is somewhat difficult to determine what they were used for, and just why black porphyritic pebbles were selected in preference to others. Many hundreds of conical piles of these pebbles are to be seen in marked contrast with the white sand.

Fragments of other relics are also found, but a description of them is worth a separate report.

The sloop Hattie, on her return for us, reached the island on the morning of November third. We immediately embarked, but the wind being contrary, it became necessary to tack eastwardly to Santa Barbara Island, which we reached about sundown. This is the smallest island of the group, measuring only about two miles of shore-line. But its basaltic walls rise to a height of five hundred feet, and are accessible only from one side. The top is covered with deep, rich soil. It is a favorite resort for seals and aquatic birds, which congregate here in vast numbers.

REFINING AND COINING OF THE PRECIOUS METALS.

By SVEN GUMBINNER.

Prior to the year 1858 the small yield of silver in the United State not render it necessary for the recording of any statistics.

In the following three years, as compiled from the reports of the Dir of the United States Mints, the amount of silver annually produced aged fully $100,000. But, in the subsequent years, the production of s increased rapidly, the record of recovery being for the year 1870, $16, 000.

From the years 1860–1870 the total recorded amount of silver prod in the United States was about $85,000,000; 1870–1880, the production $375,000,000. From 1870 and up to the present date, the United S heads the world's list in the production of gold and silver, and, alth the Comstock Lode has rapidly decreased in its output of these prec metals since the year 1877, other States, principally Colorado, have incre to make up that deficiency. The total production of gold in the Ur States for the fiscal year ending June 30, 1889, was $31,440,778, showi falling off of about $1,000,000 from the prior fiscal year. The total am of silver produced for the last fiscal year was $38,278,964. The produ of silver having so enormously increased, it naturally had the tenden making its influence felt in the previous relative value of gold and si

It is a fact worthy of recording, that no satisfactory explanation ca arrived at of what has actually become of the enormous output of the ious metals, for it has been fully demonstrated that what is known o world's possessions in gold is but equal to the last thirty years' produc and that of silver equal to the last seventy years' production. It therefore be reasonably concluded, that as the production has increase has the use of the same in the arts, ornaments, and its circulation as

Without a single exception, so far as known to the present date, all in nature contains more or less silver; nor has the same ever been f in its absolute pure state, that is, free from baser metals.

All California crude gold, gold bars, etc., received at the mints, portion which is not gold and the alloy, silver, constitutes the so c base metals, of which there are generally from ten to twenty parts in thousand, of antimony and lead, copper, iron, often bismuth, trac platinum and palladium, and frequently a small percentage of iridiu

All gold bars received in San Francisco from the Pacific Coast stamped with the gold fineness and value thereof by the assayers ca the same, the silver contained therein allowed for at the market rate.

California gold bullion generally contains, on an average, 12 per of silver in weight, while that of Australia has averaged but 5 per though in the past few years silver in the Australian gold has mater increased.

Generally silver bullion, as recovered from their ores, are more or auriferous. The silver produced from pyritic ore, such as contain mony, arsenic, and copper, is often very rich in gold, the poorest b silver from lead ores. But, unlike gold, large quantities of silver been extracted from the ores in which not a trace of gold coul

detected, notably at White Pine, Nevada. The gold contained in the Comstock bullion has averaged fully one third its value, frequently as much as one half.

"Doré bars" is a term applied to such silver bars as contain gold, as well as being alloyed with a small percentage of base metals. These bars are generally in the form of rectangular, oblong bars of various sizes, from one thousand to one thousand five hundred ounces each, differing in the contents of silver from six hundred to nine hundred and ninety per thousand, the base present chiefly consisting of copper, lead, often antimony, and sometimes sulphur.

Silver bars are those which are free from gold, and sufficiently free from alloys to render them fit for coinage and for the use in the arts.

"Base bars" contain a large percentage of base alloys, usually comprising lead and antimony, or copper, differing in their contents in silver from one hundred to six hundred in one thousand, and often containing gold.

MELTING AND PRELIMINARY REFINING OF DEPOSITED BULLION.

At the mints deposits of every description are invariably remelted, as a necessary precaution to a uniform mixture that a correct sample for the assay may be obtained.

"Tough gold bars" and "fine silver bars" are received at the mints without being remelted. The same are chipped and the chips assayed to ascertain the correctness of the stamped fineness.

When the gold is received in dust, gold bars, or the spongy gold from amalgamation, etc., it has to be subjected to a series of metallurgical operations to obtain a state of purity sufficient for coinage or use in the arts.

The separation of gold and silver is mostly resorted to by means of sulphuric acid, which method is a very simple one, but it is frequently rendered difficult by too large an admixture of base metals, owing to the formation of salts from base alloys; hence, the necessity of preliminary refining in crucibles.

By this means there is obtained an alloy of gold and silver, sufficiently free from base metals and suitable for the separation of the gold from the silver.

Gold melts at 1,102 degrees C., and silver at 1,023 degrees C.

When gold is in a state of fusion, even in the strongest heat of a blast furnace it is not appreciably volatile; it proves, however, to be so in the heat of the oxyhydrogen jet, as a wire of gold placed therein soon disperses in vapor.

Silver volatilizes more readily when in a molten state, and rapidly so when in free contact with air.

The fusion of the deposits is performed in black lead crucibles, placed in the ordinary wind furnace, by means of a stone-coal fire. The deposits are placed in the crucible with a small amount of borax, which latter, besides taking up the earthy impurities, assists in the fusion of the metals.

When the deposit is melted, a small quantity of niter is added, which exerts a powerful oxidizing action on the base metals. If the deposit is very base the addition of niter is repeated several times, caution being taken to use but little at a time, as by too rapid an action the contents would overflow.

The molten mass is well stirred with a black lead spatula heated to bright red, which insures a perfect uniformity of the bar after casting, and immediately after the last stirring the crucible is lifted out of the furnace

by means of a pair of long tongs, and the metal poured into a mold previously warmed and oiled.

It requires practice and dexterity to take the melting-pot from the furnace and cast the bar, so that there should be no spilling or chilling of the mass. The gold immediately sets in the mold, and the slag, consisting of the grosser impurities, accumulates on the surface.

The bar, while red, is turned out of the mold, the slag is removed from the metal, the bar immersed in the pickling vat, in which there is water acidulated with sulphuric acid, then dipped into clean water to remove the acid stain, the bar retaining warmth enough after removal to expel all moisture; after which it is cleansed of any adherent particles of slag, and hammered smooth. The bar is then chipped; that is, cuttings are taken from two diagonal corners, the chips are flattened, the rough edges of which are removed by shears, and these chips, or representatives of the melt, are assayed to ascertain the fineness of the bar.

The slags are ground finely in a mortar, or, as in the San Francisco Mint, under chili rollers, and vanned; the very small proportion of recovered grains are dried, weighed, and allowed for with the chips in computing the value of the assayed bar. This admirable system secures the depositor the full value of his gold. Naturally, in the metallurgical treatment of the precious metals, some loss is always sustained, but that incurred in the process above described is very rarely more than a mechanical loss of ten cents on a deposit of one hundred ounces.

The residual from the vannings is allowed to accumulate, and when sufficiently large, having been dried, is melted with a small addition of borax in an old black lead crucible at a high heat. The crucible and contents are allowed to remain in the furnace over night to cool. The crucible is then broken and the small particles of metal found adhering to the bottom are often principally silver from the action of the niter. It will be found that invariably the amount of gold recovered from these slags does not return sufficient to pay for fuel and labor involved.

Frequently the spongy gold obtained by amalgamation contains such a large quantity of iron that it is necessary to separate the latter from the former by sulphur. This sulphurization is effected in a plumbago crucible.

The metal is kept at a melting heat, for when the temperature is too high the molten sulphur is wastefully volatilized. Into the molten metal sulphur is sprinkled near the sides of the crucible, because if the sulphur is thrown upon the center, particles of gold are projected to the sides and adhere thereto, and are very difficult to remove. The mass is carefully stirred with a black lead stirrer (previously heated to bright redness); the stirring is resorted to after each small addition of sulphur, the latter being added till the gold is entirely freed from its iron impurities. Sulphur, when intermixed with molten gold, has no action upon the latter, but upon the iron present it acts energetically, forming sulphide of iron; the sulphur also having a strong affinity for silver, takes up a small proportion thereof in the form of sulphide of silver, but not rapidly until nearly all of the iron has first been converted into sulphide.

The gold being now almost freed of iron, will subside to the bottom of the crucible. The crucible is now removed from the fire, gently tapped, and allowed to cool. When cold the mass is removed by inverting the crucible. It is then struck with a hammer; the gangue separates from the gold; the latter is then remelted and cast into a bar. This plan is superior to pouring the metal into a mold, because the lump of gold is better formed—is level on the top, and separates readily from the gangue.

When a large quantity of lead is present with the metal to be operated upon it frequently happens, owing, most likely, to the presence of basic sulphide of lead, that the niter employed acts but slowly in oxidizing the latter. By a free use of repeated additions of sub-ammoniac (chloride of ammonia), and alternate additions of niter, the lead will become more readily oxidized. Should any perceptible osm-iridium be present, the bar is remelted in a crucible clean of adherent flux. After melting it is kept at a high state of fusion for several minutes, the osm-iridium will settle, intermixed with the gold, in the bottom of the crucible. The crucible is then gently lifted out of the furnace and the greater portion carefully, but rapidly, poured into a mold. The remaining small portion of gold, now containing nearly all the osm-iridium, is allowed to cool in the crucible till it is set. It is then removed, chipped, and assayed separately, to determine the amount of osm-iridium. When sufficient quantities of these cones of gold with osm-iridium have accumulated to warrant the extraction of the osm-iridium, the following are the plans adopted:

To the gold with the osm-iridium, three parts of silver are added, melted, and again proceeded with, as in the first operation. The remaining silver and gold alloy, rich in osm-iridium, is several times melted with silver, whereby the osm-iridium becomes more and more concentrated with the silver and replacing to a great extent the original gold. After the last addition of silver the metal is granulated, the silver extracted by boiling concentrated sulphuric acid, and the separated gold washed out, leaving the osm-iridium. Or the gold containing the osm-iridium is dissolved by aqua regia, which does not attack the osm-iridium. The gold is afterward precipitated from its solution by sulphate of protoxide of iron, the residue well washed with boiling water, dried and fused with niter in a French clay crucible. Such osm-iridium is worth from $2 to $5 per ounce; pure iridium being worth about $20 per ounce; whereas selected grains of osm-iridium, suitable for pen points, are valued at from $50 to $70 per ounce, according to their size and quality. The osm-iridium grains are used for the points of gold pens called "diamond points." The latest discoveries have rendered the metal iridium available in the arts, many useful applications being made, such as "iridium bearings," made for fine assay scales and balances; iridium draw plates in place of ruby plates, hyperdermic needles for physicians and surgeons, which are made of gold and tipped with iridium in place of steel; and, also, for points of surveyors' and engineers' instruments.

Gold bars that are received at the mints and are of sufficient purity for the subsequent "parting" process are simply remelted without addition of any fluxes, stirred and cast into bars, chipped and assayed to determine their value.

In making a bar of cleaned skimmed metal it is necessary to throw a little powdered charcoal into the crucible before pouring into a mold, which insures a free flow of the metal from the crucible; it furthermore prevents spattering in pouring.

Gold bars received from the chlorination works are more or less brittle, therefore rendering this otherwise fine gold unfit for coinage, and this brittleness is generally ascribed to the presence of very small quantities of such metals as lead, antimony, arsenic, and bismuth, which metals have to be removed from the fine gold in order to render it "tough."

These kind of bars are remelted in black lead crucibles, in which no fluxing had been done. When in a state of fusion repeated additions of sal-ammoniac is sprinkled on the metal, which exerts its influence on the lead principally, after which repeated additions are made of small quantities

of powdered corrosive sublimate (bichloride of mercury). Care must b taken that upon the application of the latter the furnace door be at onc closed, as dense and highly injurious fumes are immediately evolved. Th corrosive sublimate is found to effect the complete toughening of the gol by which the base metals are converted into volatile chlorides, and althoug the corrosive sublimate is only thrown on the surface of the molten go (be there even two hundred to three hundred pounds of gold in a crucibl yet the whole mass is toughened by its action. When the gold is suppos to be toughened, a small portion of it is poured into a long, flat, iron mo When set and cold it is folded back upon itself by hammering, and if the slightest fracture is sustained the gold is considered tough; a lit powdered charcoal is then sprinkled into the crucible, the mass well stirr and poured into an iron mold. Silver bars are often very brittle, this c dition being caused by the presence of antimony, arsenic, etc., renderi the silver unfit for coinage. In this case the bars are remelted with go for subsequent parting.

A large amount of sulphur in silver bars renders the condition of th silver such that a correct assay cannot be had. The sulphur is reduce by introducing into the molten silver, with frequent stirring, wrought iro bars; the sulphur acting upon the metallic iron converts it into a sulphide by which a complete desulphurization takes place; the metal is then skimmed, well stirred, and cast into bars. In the mints, all silver bars excepting those which are the so termed fine silver bars, are remelted in black lead crucibles.

The metal, when fused, is kept constantly covered with charcoal, to pre vent the too easily volatilization of the silver; it is diligently stirred with a black lead spatula; a sample is then taken from the metal by a plumbag dipper and poured into water; half of the contents of the crucible is the dipped out and poured into a mold, another sample is taken by the dipper and the balance of the metal poured from the crucible into another mold

The two representative samples are dried, assayed preliminarily by cupel lation, and the exact value determined by the "humid" method. Th bars are melted with gold bars for separation.

During the period of the free coinage of silver, or when a demand i created in the market for refined silver bars, which latter are principall sent to India and China, the heretofore mentioned auriferous silver bars in place of being cast into bars again, were at some establishments cas into slabs for the direct separation by nitric or sulphuric acid, in place c being inquarted with gold and then granulated. These slabs were gene ally sixteen inches long, nine inches wide, and from three fourths to on inch in thickness.

The former method of using basket tongs, or the crane, for removin melts from the furnace, has been superseded by the following:

Two men grasp the crucible on opposite sides with tongs whose jaws ar made to suit the thickness of the crucible. The crucible is quickly lifte high enough out of the furnace to allow the metal to be poured into th mold in front of them; taking, therefore, less time than even to adjus the basket tongs.

THE FEIX CHAMBERS FOR CONDENSING OXIDIZED METALS.

Mr. J. Feix, foreman of the gold and silver refining department of th branch mint at San Francisco, invented an ingenious flue dust chambe which is used as an adjunct to the melting furnace, and undoubtedly save all, or nearly all, of the metals volatilized, especially in those furnaces i

which large quantities of silver are melted, as well as in melting ingots to be used for subsequent coinage.

Both the silver and the copper used for alloying become, under certain conditions, volatile, especially so when the molten metal is not protected by flues or charcoal dust; and volatilized copper generally carries a little gold or silver with it, and these are saved in the Feix chambers.

These chambers are built of brick directly back of the flue holes of the melting furnace. The bottoms of these chambers are about four inches lower than the flue holes; the sides project to a height of twelve feet, the width being about from nine to twelve inches; these dimensions are the inside measurements. The walls are two bricks in thickness; the top is covered with tiles, so as to admit of their ready removal. Flues from the chamber connect direct with the stack, entering the latter within a foot of the top of the chamber. Iron doors are firmly adjusted to the ends of the chamber, three at each end, through which the sweepings and dust can be drawn out. These sweepings are melted in an old plumbago crucible with borax at a high heat and left in the furnace to settle and cool, and the metal on breaking the crucible will be found as a regulus.

In the metallurgical treatment of the precious metals some loss is always sustained, which, when manipulatory skill is acquired, the proportional loss of gold and silver does not only decrease, but it is most surprising how very small the loss sustained becomes.

The precious metals having undergone the treatment as described, they are now in a condition for separation, called "parting."

PARTING BY NITRIC ACID.

This operation, upon which is based the thorough process now in practice, was first used in Venice in the early part of the fifteenth century by German assayers, who were in those days not inaptly termed "gold makers," they separating the gold from Spanish silver coin. The process was first extensively used in the Paris mint in the sixteenth century.

It is supposed that the art of refining was not fully practiced in England until about the middle of the eighteenth century.

The parting by the means of nitric acid is conducted on the large scale, on the same principle as the assaying of gold bullion.

GRANULATION OF THE ALLOYS.

The purified gold bars, and generally the "doré" bars, are prepared by adding the necessary alloy to the metal to be operated upon, the relation generally being one part of gold to three parts of silver, some establishments proportioning the quantities of one part of gold to two parts of silver. These proportioned metals are then melted together in large plumbago crucibles, and when in a state of fusion are stirred with a heavy iron rod. A thorough mixing of the metals is of the greatest importance, in order to admit of the dissolving of the silver from gold in the subsequent treatment. By a small plumbago dipper, previously heated to redness, the metal is dipped and poured into a copper tank filled with water, in which during the pouring of the metal a stream of cold water is constantly running. These copper tanks are about four feet high and two and one half feet in diameter. The metal is poured with a circular motion in a very thin stream, to prevent the formation of any lumps, by which means it is broken

into leafy substances termed "granulations." Sometimes the crucible hoisted out of the furnace by means of a clasp tongs or crane and tacklir chain, and suspended about three feet above the water tank; the workma then tilts the crucible, pouring a thin stream, till the crucible is emptie of its contents. In the bottom of the tank there is a round copper pa with handles, having a few perforations on one extremity, and capable holding from four hundred to five hundred pounds of granulations. Th pan with the granulations is then hoisted out of the tank by means of crane and tackle and allowed to drain through the perforations of the pa

DISSOLVING THE SILVER.

The dried granulations are next placed in white earthenware or porc lain vessels of cylindrical shape, about two and one half feet deep, tw feet in diameter, widening at the top. Closely fitting earthernware cove are attached to these vessels, through each of which passes an earthe ware tube as escapes for the nitrous fumes which are evolved when th nitric acid, which is poured in the jar, acts upon the granulations. Th nitrous fumes are passed through a furnace of burning coke, where the are all or nearly all consumed; the nitrous oxide assists in the combustio of the fuel. These obnoxious fumes are allowed, in many metallurgica works, to escape directly through a chimney. No fumes escape in th room where the dissolving takes place, as the vessels are all inclosed in lead-lined wooden hausing. Sliding doors of glass are attached opposit each vessel. The vessels are immersed in water, contained in lead-line troughs, and the water is brought to a boiling point by steam conducte through pipes.

The charge of granulated metal is now gently boiled for about five t six hours with nitric acid of 38 degrees Baumé, which dissolves the greate part of the silver and base metals, requiring about two pounds of acid t one pound of the metal operated upon, depending, however, on the qualit of the alloy, more acid being consumed if it contains much copper. Th solution, after allowing sufficient time to elapse to subside and the gold t settle at the bottom of the vessel, is drawn off by means of a gold sipho into the chlorination vats. These vats are six feet deep, twelve feet squa at the bottom, and nine feet at the top, made of wood two and one ha inches in thickness. The nitrate solution is diluted with pure water prevent the forming of crystals upon cooling.

PURIFYING THE GOLD.

The residue, now almost pure gold, is again subjected to boiling wit strong nitric acid for about two hours, the solution siphoned off and adde to the previously drawn solution, and finally the now remaining spong gold is boiled once more for one to two hours with nitric acid.

This last solution, after being siphoned off, is separately put aside, an as it contains but very little nitrate of silver, is used again for the dissolv ing of the fresh granulations. The pulverent gold is washed in larg earthenware dishes with boiling distilled water, being constantly kept i agitation, so as to remove all the nitrate of silver remaining, and as lon as the washings show the least turpidity by addition of salt water. Thes washings are added to the first solutions, except such in the last stag which are drawn into a large reservoir and treated with salt to precipitat the silver into chloride, to be subsequently separately treated and melte The pulverent "sweetened" gold, which will be again referred to, is the

pressed and melted. Either silver or gold is termed "sweet" when they are free from any impurities. It is claimed of this process, if care is exercised in every stage of procedure, that the subsequent gold bars will retain but three parts of silver in one thousand.

A SECOND METHOD OF DISSOLVING THE ALLOYS.

Another method of digesting the alloy is by nitric acid of 39 degrees Baumé, which generally dissolves the silver in four to five hours; distilled water is added to prevent crystallization, and the undissolved contents allowed to subside, after which the nitrate of silver solution is siphoned into the cholorination vats. The pulverent gold is washed from two to three times with distilled water, allowing the gold upon each washing to subside, and the washings are siphoned off into the chlorination vats.

PURIFYING THE GOLD WITH SULPHURIC ACID.

The gold is ladled from the earthenware jars into a wooden circular filtering tub, with a false, perforated bottom, upon which drilling is spread and the edges of the same closely tucked, so as to prevent the loss of any of the pulverent gold. Each tub is two feet in diameter and two feet deep. The washing with pure water is again resorted to until the gold is "sweetened;" *i. e.*, until every trace of nitrate of silver has disappeared. The gold is then introduced into castiron vertical cylindrical-shaped kettles, and digested for about five hours with concentrated sulphuric acid, thereby converting the silver and base metals that were still undissolved in the pulverent gold into sulphates; the contents are allowed to subside. The solution is then ladled off with an iron ladle into a lead-lined tank, the treatment of which is proceeded with as described under "parting by sulphuric acid." The gold is once more subjected to boiling concentrated sulphuric acid for a couple of hours; again allowed to subside, the acid ladled out, put aside, and used again for another operation for the first boiling. The pulverent gold is finally emptied into the wooden filters and washed with boiling water till sweetened; *i. e.*, that blue litmus paper, moistened with the washing, does not turn red. The acidulated water is run off through a plug-hole, below the false bottom of the filter, into a large reservoir, where the silver in the solution is precipitated by salt as a chloride. After settling, the clear solution is run off and these chlorides treated as hereafter described.

PRESSING AND DRYING THE GOLD.

After the spongy mass of gold has been drained (which following treatment is the case with all gold by parting in any of the humid processes) it is pressed in a hydraulic press, which exerts a pressure of about forty tons to the area of the plunger face, forming the gold into round cakes of twelve inches in diameter and from four to five inches thick. These are placed in round castiron pans, previously smeared with ashes moistened with salt water or pipe-clay, and conveyed to a drying furnace capable of holding one hundred to one hundred and twenty such cakes at a time, where they are slowly dried and heated to a cherry red. The cakes when cooled are broken into pieces of convenient size for the subsequent melting and casting into bars.

TREATMENT OF THE NITRATE SOLUTION.

The nitrate of silver solution in the chlorination vats is treated by addition of a strong solution of salt water in sufficient quantities to convert all the nitrate into chloride of silver. A constant agitation is kept up by means of revolving wooden agitators, resembling the agitator of a silver mill, which are run by steam power. The whole is allowed to settle, generally over night, the clear solution (now nitrate of soda) is drawn off through faucets and filtered, thence conveyed into the large reservoir mentioned before. The precipitated chloride of silver is washed several times with hot water under repeated agitation, the supernatant liquid drawn off and the precipitate finally removed to large circular wooden filters arranged as the gold filters with linen drilling, where the chloride is washed with boiling water until "sweetened," thereby rendering it free from all nitrate of soda and free nitric acid. The filtering tubs are three feet deep, three feet in diameter at the top, tapering to two and one half feet in diameter at the bottom.

REDUCTION OF THE CHLORIDE OF SILVER.

The drained chloride of silver is removed from the filter and placed in the lead-lined vats, about six feet long, two feet deep, and three feet wide, which are for the purpose of reducing the chloride of silver to the metallic state. This reduction is accomplished by adding to the silver chloride granulated zinc, water, and sulphuric acid. Thirty-three pounds of metallic zinc, and fifty pounds of sulphuric acid, of 60 degrees Baumé, extracts one hundred pounds of silver from the chloride.

Over these vats lead-lined wood-hoods are placed, connecting with a flue into the chimney, to carry off the hydrogen gas generated.

The granulated zinc is introduced all over the chloride, some water added, and finally concentrated sulphuric acid. Frequent stirring by hand with wooden paddles is resorted to, more diligently at first, as the action at first is very energetic, otherwise lumps are formed, which envelop unreduced chlorides, depriving them of the action of the zinc and acid.

A complete reduction is the most essential point to be gained in this operation, to ascertain which samples of the silver are taken and washed with concentrated ammonia; the ammonia solution is neutralized with nitric acid slightly in excess, and if no milky turpidity is perceptible the reduction is complete.

PURIFYING THE SILVER.

On the complete reduction of the silver, generally occupying six hours a small quantity of sulphuric acid, of 40 degrees Baumé, is added, to dissolve any of the zinc not acted upon. After the zinc is dissolved the vats are filled with hot water, agitated, allowed to subside, and the solution is then siphoned off into the large reservoir, where small particles of silver are recovered. These last operations are repeated several times The zinc and acid employed in this process are a complete loss.

The dark gray pulverent silver is removed to the large circular wooden filters, washed with boiling water until sweetened, when it is pressed and dried, as described with the pulverent gold, then melted; of which, more hereafter.

›re referred to, the silver "slabs," without inquartation, are placed rthenware vessels, digested, and operated upon in the same man- the process of inquartation, with this modification, however, that ›rent gold, being of so small a quantity, is not further acted upon dissolving of the silver, but sufficient is allowed to accumulate ıt the completion of finishing the refining of gold.

PARTING BY SULPHURIC ACID.

paration of gold and silver by nitric acid is now almost universally ed by the sulphuric acid process. The method with nitric acid is ›ensive on account of the use of platinum, porcelain, or earthen- ›els, as well as the loss of the nitric acid, zinc, and sulphuric acid. igin of the sulphuric acid process is ascribed to the German chem- :kel, in the seventeenth century, and is afterward referred to in :le of the eighteenth century, by Scheffer, of Sweden.

D'Arcet, Inspector-General of Assays of the Paris Mint, however, e first practical adoption of the parting on the large scale by means ıric acid in platinum vessels; the first refinery for such purpose cted in Paris in the year 1802.

lar establishment was afterwards erected in London, in the year Mr. Mathison, melter and refiner of the London Mint.

ost satisfactory results obtained by this process, in order to effect est state of separation, is by proportioning the alloy to be operated quantities of one part of gold to two and one half parts of silver, ı the refined gold will contain an average, after parting, of only s of silver in one thousand. When the alloy is of the proportion ırt of gold to two parts of silver, the separation of the silver is not complete; the gold will generally carry from eight to ten parts of one thousand, and if proportioned in excess of one part of gold to s of silver, mechanical difficulties arise, the gold remaining too , thereby preventing the sulphuric acid from thoroughly permeat- emaining alloy, and the last parts of silver will not be as com- xtracted.

andard of fine gold required by the United States Mints is nine and ninety fine, not allowing of more than ten parts of silver in sand. A small percentage of copper in the alloy facilitates the ›n of the two precious metals; yet the alloy should not contain ›er cent of copper, as the sulphate of copper formed is but spar- uble in concentrated sulphuric acid; but a small percentage of litates the dissolving of the copper alloys.

usually dissolve more readily and consume less acid, the less ıey contain.

at times interferes with the solution, but the presence of 7½ per :opper and 5 per cent of lead at the highest, does not impede the ›n.

the economy with which this process is conducted, and the com- y low price of sulphuric acid, as well as a return of the copper ›huric acid in the shape of bluestone, it admits of being profitably to the refining of silver containing 0.05 per cent of gold only,

which, however, is not the case with silver containing even 0.10 per cent of gold by parting with nitric acid.

At the Vienna Mint auriferous silver containing about 0.09 per cent of gold is profitably treated, and likewise at the Freiberg refinery with 0.04 to 0.08 per cent of gold.

FURNACES AND VESSELS USED IN PARTING.

The parting of gold by sulphuric acid has been greatly facilitated by the use of platinum vessels; but on account of their great expense—$2,000 to $3,000 each—they are almost entirely replaced by castiron vessels. These are cast of white pigiron, and resist the action of concentrated sulphuric acid, the iron becoming electro-negative. The air must be excluded from these vessels as much as possible, and the using of dilute sulphuric acid must be avoided, as it dissolves the iron, forming sulphate of protoxide of iron, which, to a certain extent, reduces the sulphate of silver to an insoluble basic salt. After using, the inner surface of the iron vessel becomes coated with silver, which, to a great extent, prohibits the action of the acid on the iron. The iron of these vessels must be fine grained and compact, as well as free from all blisters. By continuous usage they will last two years, wearing down to one quarter of an inch in thickness, after which they cannot be used with any safety. In some European mints the iron that is used for these vessels contains from 3 to 4 per cent of phosphorus, thereby prolonging their durability.

These castiron vessels are either rectangular or vertical cylindrical shaped. The former are placed in a row of four, incased in iron plates in a brick furnace. They are uniform in size, two and one half feet long, one and one half feet wide, and two feet deep, three quarters inch in thickness, slightly flaring at the top, with flat bottoms one and one quarter inches in thickness. They are furnished with iron lids one half inch thick, cast into two halves, and are hung by chains with pulleys and counterpoised, one half provided with a lead tube, through which, during the operation, the anhydrous fumes evolved are passed through leaden conduits connected with leaden chambers, in which they are reconverted into sulphuric acids; or the fumes passing through the leaden pipe communicate with larger lead pipes partially filled with water, in which some sulphuric acid condenses; the surplus fumes, however, are here lost, passing into a well drawing chimney out into the air. Over the iron frames of the furnace a closely fitting lead-lined housing is attached, with sliding doors, by which the fumes are carried out into the chimney during the subsequent ladling out of the contents of the vessels into the receivers.

The rectangular vessels are the most preferable, the flat bottom presenting a larger surface to the fire, thereby exposing the gold to an even action of the heat; the action of the acid is uniform, and the gold in the last stages of dissolving is more easily stirred. They are also more economical, using less fuel than the cylindrical shaped vessels, and the acid is brought quickly to a boiling point, and readily kept boiling to the finish.

The cylindrical shaped vessels have closely fitting covers attached, made of castiron, kept in place by iron rings, which are screwed to the rims of the vessels. The covers are provided with openings through which the alloys and acids are introduced, and through which the stirring is done. From these openings the operation is readily watched, and from whence also the solution is ladled out. There is another opening in the cover to which a large leaden pipe bent at right angles is attached, passing into leaden conduits, through which the sulphurous anhydride escapes into a

chimney. The evaporating sulphuric acid, with small portions of sulphate of silver, are caught in these conduits in water.

SOLUTION OF THE SILVER.

The parting methods by sulphuric acids is based upon the solubility of silver in boiling concentrated sulphuric acid (66 degrees Baumé), converting the silver into sulphate of silver, with the evolution of sulphurous anhydride; and the insolubility of the gold which remains in the bottom of the vessel in almost its purity, and converting the base metals into salts. The decomposition of silver represented by the following formula takes place: $2Ag+2H_2SO_4=Ag_2SO_4+SO_2+2H_2O$. The alloy of gold and silver, having been brought to its proper standard, the proportion of one part of gold to two and a half parts of silver is found to be the most suitable for the action of the sulphuric acid, is melted, granulated, and placed in the castiron vessels, the charge varying as to the quality of the alloys.

In dissolving the alloy about two to two and one half parts of sulphuric acid are usually employed, notwithstanding the fact that 0.9 parts concentrated sulphuric acid dissolves one part in weight of silver, but in practice more acid is generally used to redissolve the pasty crystalline sulphates, which would otherwise inclose and impede the dissolving of the silver. Here, also, the amount of acid employed depends considerably upon the quality of the metals, more so if much copper is present. About half of the sulphuric acid to be employed is added first to the granulations, and the vessels gently heated by means of a wood fire. Effervescence commences at the boiling, great precaution being here observed, so as to prevent portions of the contents of the vessel from overflowing, which is insured by the uniform admixture of cold acid in small quantities from time to time, and the fire being regulated accordingly. A temperature of 650 degrees Fahrenheit is maintained, which is the boiling point of the acid. The effervescence will gradually diminish, and by the time the last addition of the acid has been made, nearly all of the silver will be dissolved. It is necessary to stir the charge of granulated metal from time to time to prevent it from packing. Towards the completion of the dissolving, frequent stirring with an iron tool is resorted to, by which the remaining undissolved alloys will be freed from the surrounding sediments, and bared to the action of the acid. The parting should be completed in from three to four hours from the commencement of boiling. If the alloy contains a large percentage of copper, lumps of anhydrous sulphate of copper are formed, which adhere to the bottom of the vessel. To prevent the formation of these lumps constant stirring must be resorted to in the last stages of dissolving. A small proportion of copper in the alloy is an advantage, as the anhydrous sulphate of copper adheres firmly to the vessel, assisting in closely collecting the gold as well as clarifying the solution; and the iron of the vessel is less attacked, whereby less sulphate of protoxide of iron is formed.

Twelve to twenty pounds of sulphuric acid, of 55 degrees Baumé, are now added, to assist in the clarification of the solution. This acid is obtained as mother liquor from the crystallization of the bluestone. The contents of the vessels are stirred and boiled for fifteen minutes, after which the fire is withdrawn, the solution is allowed to subside and clarify in order that the gold may be deposited in the bottom, which will have taken place in an hour. The silver solution is next bailed out with iron ladles into the dissolving vat.

PURIFYING THE GOLD.

The gold remaining in the iron vessels containing crystallized sulphate of silver and base salts must, therefore, again be subjected to the action of boiling concentrated sulphuric acid for an hour, the acid having been previously heated in another vessel. During this hour a high heat is maintained, with copious evolution of sulphurous anhydride, after which the remaining hard and heavy gold will rapidly subside to the bottom, and the liquor is bailed out into the dissolving vat.

The gold is once more digested as above for an hour, when the fire is withdrawn, and this last acid containing but little silver, is set aside for the dissolving of fresh alloys.

The gold, while still hot, is dipped out from the vessel with an iron strainer into a lead-lined filter box containing hot dilute sulphuric acid, obtained from the condensers, and the last portions of gold are taken out with a hoe-shaped iron. The filter has a closely fitting cover attached, through the center of which the hot gold is introduced by means of a funnel reaching through the cover. The acid is diluted with hot, pure water, and the gold is washed with hot, pure water. These first washings are filtered into the injecting vat. These washings are continued until the wash water ceases to give the reactions for acid with litmus paper, and for silver by the test with salt water. The work is then proceeded with as described by parting with nitric acid. The gold obtained by this method will be almost "tough" upon melting, containing but a trace of lead, and will retain but three to four parts of silver in one thousand.

SETTLING THE SOLUTION.

The dissolving vats are made of wood and lined with heavy sheet lead. They are ten feet long, three and one half feet wide, and two and one half feet deep, and are provided with leaden pipes for the direct injecting of steam into the solution. They have closely fitting covers attached, in two halves, made of wood and lead-lined, for the inner covering, and hung by chains and counterpoised. Into these vats the washings, etc., from the "sweetened" gold and silver are injected, until two thirds full, by a steam injector made of lead. The supernatant liquor from the gold is bailed in through a funnel serving as a gutter, until the contents reach to within three inches of the top. The temperature is then raised to the boiling point by turning on the steam, frequently stirring the solution with wooden paddles, by which the sulphate of silver, which began to fall on cooking, is redissolved. Ninety parts of boiling water generally dissolves one part of sulphate of silver.

The liquid is brought to a specific gravity of 24 degrees Baumé. If it is brought up to from 26 degrees to 28 degrees Baumé, the subsequent precipitation with metallic copper is imperfect, the liquid showing a sparkling of separating crystals of sulphate of silver, requiring an addition of water to reduce the strength of the solution. The steam is shut off and the contents are allowed to settle, the boiling and settling being finished in three hours. This solution contains all of the sulphate of copper, and nearly all of the sulphate of silver. The sediments will consist of nearly all of the lead from the alloy, some basic sulphate of silver, and particles of gold, as well as graphite from the iron vessels. The sulphate of lead upon being bailed from the dissolving vessels into the water forms a milky solution, *precip*itating entirely in the water as an insoluble sulphate.

PRECIPITATION OF THE SILVER SULPHATE.

The clear solution is drawn off by means of a lead siphon while still very hot into the precipitating vats set at a lower level. These vats are of the same dimensions and lead-lined as the dissolving vats. Care must be exercised that none of the sediments are drawn over. In these precipitating vats copper plates, closely set together, are suspended. These plates are cast by remelting the commercial ingot copper, pouring the copper into iron-slab molds of two feet in length, ten inches in width, and from one to one and one quarter inches in thickness, each plate weighing from seventy to eighty pounds. These plates are used over again, until too thin for precipitating the silver, when they are remelted and cast into new plates.

The old sheet copper from vessels, when available, is well adapted for precipitating the silver in place of cast plates. The precipitating vats are closed with wooden covers to retain the heat of the solution, as the sulphate of silver is more rapidly converted into the metallic state in the hot than in the cold solution. The copper rapidly converts the sulphate of silver to the metallic state. In the course of four to five hours the last traces of silver sulphates are completely decomposed. To produce one hundred parts of silver from the solution about thirty parts of copper are dissolved, yielding one hundred and fifteen parts of crystallized sulphate of copper.

PURIFYING THE METALLIC SILVER.

The copper plates are divested of the heavy coating of metallic silver and cleansed of any adherent particles in the solution. The solution is allowed to settle to deposit any suspended particles of silver, which will occupy about an hour. The clear sulphate of copper solution, still of 24 degrees Baumé, is tapped off by a leaden siphon into an evaporating pan for crystallization. The metallic silver is removed with copper shovels to copper sieves standing on a second sieve covered with drilling; care being taken that no small particles of copper remain with the silver.

The silver is next washed with boiling water. As the first washings contain a large quantity of sulphate of copper, they are run into the injecting vat for the use of the dissolving vat, and the washings are continued until sweetened. The metallic silver is then pressed into round cakes of ten inches in diameter and four to five inches thick, by hydraulic pressure, thus retaining a moisture of about 10 per cent, and are then proceeded with as in the nitric acid process. The silver obtained as herein described will be from nine hundred and ninety-eight to nine hundred and ninety-nine fine, without any refining with niter upon melting.

REDUCTION OF THE SEDIMENTS IN THE SETTLING VATS.

The accumulated sediments in the dissolving vat, consisting of sulphates of silver and lead and some gold, are removed to a smaller vat and treated with metallic copper and steam, thereby reducing the sulphate of silver to the metallic state.

The sulphate of lead is not acted upon by the copper. The remaining metallic copper is removed, the solution given time to settle, and is then siphoned off and added to the injecting vat. The residue is then collected, thrown upon a filter, washed, dried, and heated to redness. It is next melted without the addition of any fluxes, in a clay crucible; the lead remains as a sulphate and forms a slag, covering the auriferous sil-

ver. This slag is removed and remelted with powdered charcoal, by whic the lead is reduced to its metallic state, containing a large percentage silver and some gold.

A SECOND METHOD OF PARTING—SOLUTION OF THE SILVER.

Another method of parting by the sulphuric acid is proceeded with i the following manner:

The granulated alloy is placed in the cylindrical-shaped vessels an the dissolving is proceeded with in precisely the same manner as in th rectangular vessels. The dissolving will be completed in about four t five hours. The liquors are allowed to cool and settle over night. Th gold will form in a firm sediment at the bottom of the vessel, togethe with some sulphates of silver, copper, and lead, as well as sulphate of pr toxide of iron. The solution is discharged next morning from the kettle by being siphoned off directly into the precipitating vats. The gold i pushed to one side to allow room for the siphon. In this process n dissolving vats are employed.

PURIFYING THE GOLD.

The gold is transferred to smaller and deeper cylindrical-shaped iro vessels and boiled twice with sulphuric acid for about two hours. Th last acid, containing but a small quantity of sulphates, if clear, is use for dissolving alloys. Upon settling, however, the lower portion of thi acid is often a muddy liquid. This muddy appearance of the liquid i probably due to the presence of anhydrous sulphate of protoxide of iro which is insoluble in the boiling concentrated acid, as also due to scales graphite, which are detached by the solvent action of the acid upon the iro vessel. This muddy liquid is bailed into a smaller vat, and the sulpha of silver contained therein reduced to the metallic state by the addition granulated zinc. It is next washed, dried, and melted with bicarbonate soda, no other flux being able to remove the graphite so rapidly. Or th metal obtained is fused in old black lead crucibles, to which some bora is added, and any sulphur it may contain is removed by the addition of ol iron grate bars, with which the metal is repeatedly stirred, leaving the gra bars in the metal during the interval of stirring. The iron sulphide th obtained will combine with the heavy dross upon the molten metal, th greater portion of the dross being the graphite, which is skimmed or ladle off with a small crucible cover. The surface of the metal is finally cleanse with a little bone-ash, and afterwards some borax added to facilitate th skimming, after which the metal is poured into molds, resulting in do bars of nine hundred and forty to nine hundred and sixty in fineness o silver and gold.

The skimmed dross so obtained is then pulverized and vanned, b which means all of the globules of metal will be readily separated. Afte being dried they are melted with borax and poured into a mold, result ing in a small bar of about seven hundred to eight hundred fine.

The residue gold in the dissolving vessels, after the final boiling wit sulphuric acid, is transferred to the filter boxes and proceeded with a already described. By this method considerable lead remains in the gol also silver. Sulphate of lead is, to a great extent, soluble in boiling sulphur acid of 66 degrees Baumé, and much more so when the acid is saturate with silver. On the cooling of the solution, however, a large proportion of th lead settles with the gold as an insoluble sulphate, which, in reboiling wit

concentrated acid, remains as an insoluble sulphate, thereby rendering the gold, upon melting, not only extremely brittle, but refining in the crucible must be resorted to to extract the lead. The gold, by this mode of parting, will contain from eight to ten parts of silver in one thousand.

PRECIPITATION OF THE SILVER SULPHATE.

The clarified solution from this method is bailed direct into the precipitating vats. The copper plates are disposed upon the bottom and upright along the sides of the vats. The vats are filled within one third of full with dilute liquors obtained from the first washings of gold and silver. As soon as the sulphate of silver solution has been added, the steam is turned on and the solution brought to a boiling point.

Most of the sulphate of silver separates when it comes in contact with the water; on boiling it redissolves, which solution is greatly promoted by constant stirring with wooden staves. The precipitation of the silver takes place more rapidly if the stirring is continued for some time, and if this is adhered to and the solution does not exceed a specific gravity of 24 degrees Baumé, the precipitation will be effected in about five to six hours. It is then proceeded with as previously described.

Upon melting this silver, considerable lead will be found associated with it—as much as from ten to twelve parts in one thousand, depending upon the original alloy operated upon. In parting auriferous silver, the metal is first granulated.

PARTING OF DORÉ BARS.

It has, however, become a custom to dissolve "doré" bars without first granulating, which is found not only to facilitate the regular action of the acid, but also to give a coarser gold, which is more easily washed than the mushy gold from the granulations.

This operation was first successfully accomplished upon Comstock bars by Mr. John Reynolds about twenty-five years ago, who at that time was employed at the San Francisco Assaying and Refining Works. These bars, weighing about one hundred pounds each, were placed in the flat-bottomed iron vessels, and the whole of the silver dissolved in from three to four hours. The charges in each vessel were enlarged to almost one third more, in weight of metal, than for the dissolving of the granulations. The gold did not need a second boiling, and upon being melted averaged nine hundred and ninety-six fine, and the parted silver being nine hundred and ninety-eight to nine hundred and ninety-nine fine.

A THIRD METHOD OF PARTING.

Auriferous silver, with but a small percentage of gold, is either acted upon in bars or in a state of granulations in the same manner as in the treatment of argentiferous gold, in so far as in the dissolving in the iron vessels. As soon as all of the silver is dissolved, very little time is allowed for settling, the turbid solutions being drawn off by means of a platinum siphon into the dissolving vat. The residue gold is left undisturbed in the iron vessels. Fresh granulations or bars are added thereto, again dissolved, and siphoned off into the dissolving vats, which operations are repeated until sufficient gold has accumulated in the dissolving vessels to finish that portion of the refining. This admits of an uninterrupted refining. The sediments in the dissolving vat are treated in the same way as before referred to, as also all necessary subsequent operations.

All the last continuous washings during the "sweetening" of the gol or silver are run into large reservoirs, where they are treated by salt wat to precipitate the last traces of silver as well as to collect any escaping fin particles of gold or silver. The residue is collected and treated with othe sediments for reduction.

The floor of the refineries are generally covered with sheet lead so tha in case of spilling or of an accident the floor is readily mopped up. Th filter cloths, mopping cloths, old wood filters, etc., are finally burned, the ashes are acted upon to reduce the metal contained therein and added to other sweeps, which are credited to the melting department.

THE CRYSTALLIZATION OF THE SULPHATE OF COPPER SOLUTION.

The solution of sulphate of copper, resulting from the precipitation of silver, is concentrated by evaporating in wooden lead-lined vats heated by a series of steam pipes running across the bottom. These vats are twelve feet long, eight feet wide, and two and one half feet deep. Sometimes the evaporation is effected in lead pans made of the heaviest sheet lead placed upon castiron plates one inch in thickness, which are heated by a wood fire.

The solution from the precipitating vats (still of 24 degrees Baumé) is transferred by means of a lead siphon to the evaporating pans and concentrated to 40 degrees Baumé, and thence run off into the crystallizing tanks which are made of wood and lined with sheet lead; they are eight feet long four feet wide, and four feet deep.

Crystallization is completed in from ten to twelve days, according to the temperature of the surrounding atmosphere, whereby crystals of crude blue vitriol are obtained. The acid mother liquors remaining, and of 36 degrees Baumé, are raised by means of an injector back to the evaporating vessel and concentrated to 45 degrees Baumé, which, upon being run into the lower vats, yield a further crystallization of impure sulphate of copper.

The acid solution from this last crystallization is next concentrated t 55 degrees Baumé, which, upon cooling, deposits anhydrous sulphate o copper with sesquioxide of iron in combination. This clear acid solutio is drawn off and used in the refining process as heretofore described.

All the impure deposits which are separated from the acid liquors ar redissolved in water, and recrystallized, yielding a further supply of impur crystals. To obtain a merchantable bluestone, all the impure crystal thus obtained are dissolved in water in the evaporating vessels, the solutio heated and concentrated to 36 degrees Baumé, run into the lower vats, an recrystallized. The resulting mother liquors of 25 degrees to 30 degree Baumé, are again concentrated to 36 degrees Baumé, yielding a furth supply of good crystals and a mother liquor of 30 degrees to 32 degree which is added to and used with the first liquors of the precipitating vat The acid mother liquors become in time too much charged with iron, an will be of no further use; when such is the case the copper is recovered b precipitation on scrap iron. In Europe the iron is recovered from the mother liquors by concentration and crystallization as copperas.

After the removal of the mother liquor from the recrystallization, th bluestone is found adhering to the sides and bottom of the crystallizin tanks, the heaviest deposit being on the bottom, the crystals of whic however, are smaller than those on the sides. They are detached b means of copper chisels, removed to plates of lead pierced with hole sprinkled with water to remove any adherent dirt, and left to dry, aft which they are placed in barrels for the market. In place of the recta gular crystallizing vats, round vats are frequently used, of three feet

diameter and four feet in depth. These are bound with copper hoops, as sulphate of copper acts readily on iron. After the tanks have been filled with the solution for recrystallization, they are covered to prevent a too rapid cooling, as a gradual lowering of the temperature contributes to the formation of much larger, more beautiful, and more neutral crystals, which have a preference in the trade. The crystallization will be completed in from five to six days.

The round vats are preferable, as they are more convenient to handle, and can be turned bottom up, after the liquor is drawn, to drain, previous to detaching the crystals. It is always best to keep the crystals in a somewhat dark place till perfectly dry, so as to retain their deep blue color.

One pound of metallic copper, with 1.2 pounds of sulphuric acid of 60 degrees Baumé, produces 3.8 pounds of crystallized sulphate of copper.

THE GUTZKOW PROCESS.

ANOTHER METHOD OF PARTING BY SULPHURIC ACID.

The recovery of silver from the sulphate solution obtained in dissolving the alloys by means of sulphuric acid may also be effected by ferrous sulphate, thereby overcoming the tedious manipulation of precipitating by copper and recovery of bluestone in "parting refineries."

The process to be described is undoubtedly the best method of all those before mentioned in this article, being the most expeditious and the least expensive.

This method is the invention of Mr. F. Gutzkow, patented by him in the United States and England, and was successfully and profitably operated by him as early as 1867, at the then San Francisco Assaying Works, at San Francisco.

SOLUTION OF THE ALLOYS AND SETTLING OF THE SOLUTION.

The granulated alloys, or bars, are dissolved by sulphuric acid in iron vessels, similar to other processes described. The sulphate of silver solution obtained in the dissolving vessels is siphoned off into large iron pans, which contain the heated mother liquors of a previous operation. The siphoning is done by means of a vacuum formed by steam.

These pans are provided with closely fitting castiron covers resting on india rubber bands, thereby rendering them air tight during the addition of the sulphate of silver solution into the mother liquors. The covers are then raised by means of a pulley, and pure water added in sufficient quantities to give the silver solution a specific gravity of 58 degrees Baumé. The object of reducing the solution from 66 degrees to 58 degrees Baumé, by addition of water, is to clarify the liquor, by which the precipitation of the sulphate of lead assists in the clarification, and any particles of gold which may be in the solution readily settle in the bottom of the pan. The solution is again covered, without the use of the india rubber bands, the pans are heated by a wood fire beneath, and sufficient time is allowed for the clarification of the solution.

CRYSTALLIZATION OF THE SILVER SULPHATE.

As soon as the solution has become perfectly clear it is drawn off by a siphon into another castiron pan, which remains uncovered, and in which the crystallization of the sulphate of silver is effected. These pans are rectangular, and not over one and one half feet deep. The solution is allowed to cool to 80 degrees Fahrenheit, at which temperature nearly all of the sulphate of silver will have become crystallized. The cooling of the solution is assisted by each crystallizing pan being placed inside of a lead one, allowing of a flow of water between the two pans.

The supernatant liquors are then reconveyed into the first pan, which is the receiver of fresh sulphate of silver from the dissolving vessels, which is done on the principle of the Giffard injectors.

The crystallizing pans are so arranged that the liquid therefrom (when the crystallization is completed) runs into a small leaden well, from which the liquid is injected into the receiving pans, and into which also the last acid from the crystals drains into a vessel placed beneath the pan. The sulphate of silver crystals are thereby rendered as free from acid as possible, to facilitate their reduction into the metallic state.

The mother liquors from the crystallization of the sulphate of silver will naturally accumulate in quantity, for, as already stated, it requires less than one part of sulphuric acid by weight to dissolve one part of silver. The surplus of this mother liquor is therefore utilized as acid upon fresh alloys in the first stage of the operation.

DECOMPOSITION OF THE CRYSTALLIZED SILVER SULPHATES.

After the crystals (contaminated with oxide of copper) have been thoroughly drained they are shoveled into a wooden filter, similar to those in the other processes, with a stopcock between the real and false bottom attached. Upon the drilling of the filter a layer of precipitated silver is spread to facilitate the reduction of the silver to the metallic state.

A solution of sulphate of protoxide of iron of 25 degrees Baumé, and as nearly neutral as possible, is kept prepared in a large tank heated by steam. This hot solution is conducted in a small continuous stream, by means of a siphon, from a vat on a higher level flowing upon the mass of crystals on the filter, permeating the crystals, thence draining into the false bottom, from whence it runs, by means of a stopcock, into a tank, the crystals being occasionally stirred; the filtrate passing through changes its color from brown to a slight greenish.

The sulphate of protoxide of iron first dissolves the copper salts, then reduces the sulphate of silver to its metallic state and finally taking up, the acid set free, is converted into sulphate of sesquioxide of iron. The first filtrate is run into a small tank, provided it has a bluish color, owing to the presence of copper. This blue filtrate is allowed to become cold, whereby some remaining silver is precipitated; after the settling of the latter the solution is siphoned into a vat, in another part of the building, where the copper is recovered by means of scrap iron. This copper is dried, placed in a reverberatory furnace for oxidation, next dissolved in dilute sulphuric acid, and the sulphate of copper crystallized as already described.

As soon as the filtrate, passing through, changes to a deep brown it is run into another tank, and upon becoming cold will yield a further small precipitation of silver, which, in conjunction with that obtained from the bluish filtrate, is used as a filter layer for the succeeding reduction. The

brown colored solution is now run into another large tank, in which some sheet iron is placed to change the converted ferric sulphate back to the original ferrous sulphate, where the last traces of silver and copper are precipitated, forming a muddy mass, which is reconveyed about once a week into the first settling pan. The ferrous sulphate solution as soon as it has become clear is forced back by an injector into the tank for further use on fresh crystals.

The reduction of the crystals of sulphate of silver to the metallic state occupies three to four hours, resulting in a heavy metallic mass, which retains the shape of the crystals. The reduction is completed when the solution passing through the filter assumes a pure green color. Sweetening as in the other processes is then resorted to, for the purpose of removing all the ferric sulphate, which is continued with hot water until the washings passing the filter give no blue precipitate on the addition of yellow prussiate of potash. The silver is then compressed and similarly proceeded with as in the other processes, which is the same with the gold obtained in dissolving by this process.

The residue in the first heating or settling pan, consisting of the sulphates of lead, basic salts, with graphite and fine particles of gold, are gathered once a month, sweetened with hot water, thereby dissolving any of the sulphate of silver. The residue is then treated with zinc, and proceeded with as described in another process.

MELTING OF THE REFINED METALS.

Previous to the charging of large quantities of metal into the crucibles, the crucibles, of sizes varying as to the amount of metal to be melted, are placed in a series of furnaces, the most common in use being fourteen inches square, fifteen inches deep in front and twenty-four inches in the rear, with level grate bars. They are built of common bricks, lined with fire-bricks, and have heavy castiron frames. The iron doors on top incline steeply towards the front, and slide in a groove. On the grate, formed of six to eight movable iron bars, supported by cross bars let into the brick work, a half fire-brick is placed for the crucible to rest upon. The brick protects the case of the crucible from the stream of air which is necessary for the combustion of the fuel, but which would destroy the crucible. Either coke or stone coal is employed as fuel. The black lead crucibles in which the fusion is effected should be well annealed before being placed in the fire to be charged, as they are liable to crack by too sudden an application of heat.

The annealing is generally done by placing the crucible on the front plate of the furnace, with the furnace door thrown open, exposing them to the heat of the fire after the day's melting is completed. The crucible is placed upright in the furnace on the brick and covered with a plumbago lid. A layer of charcoal of a few inches deep is then thrown around it, and then a layer of charcoal, previously ignited in another furnace, is thrown upon the first or unignited layer, and the furnace, after full ignition of the charcoal, is filled with coke. When the crucible is heated to a bright red, the metal is placed therein by means of tongs.

MELTING AND TOUGHENING OF THE PURIFIED GOLD.

The gold obtained by the parting processes is rarely sufficiently fine, soft, or ductile, owing to the presence of small quantities of lead and antimony. This hard and heavy gravelly-appearing gold is broken up easily in suit-

able fragments for the crucible, in which it is placed with the addition of a small quantity of borax. From four to five thousand ounces are generally operated upon, in one crucible, to be toughened. As soon as the first charge has partly melted, further additions of gold are made, until the crucible is sufficiently full of molten metal to permit of refining and toughening. To render the charge completely tough, it is first treated with niter, as the platinum retained by the gold lessens its ductility, and a trace of lead is sufficient to render the gold brittle.

In using niter on large quantities of metal some bone-ash is introduced first, which floats on the molten mass, as in making black lead crucibles coke is incorporated, which is readily attacked by fusible oxides converted from their metallic state by the niter. The bone-ash, to a certain extent, prevents the oxides attacking the crucibles. Niter is added to the center of the fusing mass in small doses. After the several additions of niter, the number and amount depending upon the quantity of platinum or base metals present, the slag should be of a medium consistency, neither too liquid nor too pasty, but of a degree to permit of its being readily skimmed. If the slag is too pasty, the small globules of gold cannot settle beneath it, and will be taken up in the skimming.

A skimmer is a round iron rod, with a coiled termination, of from one and one half to two inches in diameter, which is placed in contact with the slag, a portion of which will adhere thereto; it is then quickly withdrawn, pressed on the oiled plate in front of the furnace to chill and to flatten the adhering slag. It is then again touched to the slag, the operation being repeated several times, with an occasional dipping in water with an immediate withdrawal, to hasten the cooling of the slag.

If too large a quantity of slag has accumulated on the skimmer it is immersed in cold water and knocked off. If but little slag is left on the molten metal the latter is liable to adhere to the naked skimmer when brought in contact therewith; therefore, when the last particles of slag are to be removed, it is well to have some slag adhering to the skimmer. Not any slag should be left adhering to the sides of the crucible. After skimming there should be sprinkled, from time to time, small amounts of salammoniac, this being the reagent to expel the last trace of lead. Fine gold, at 2016 degrees Fahrenheit, will present a brilliant greenish color, and an experienced melter should be able to judge within one one thousandth of the fineness of this molten metal.

The refining is completed by repeated additions of corrosive sublimate, which converts the last traces of base metals into volatile chlorides. After stirring the metal, a portion is dipped out and poured into a long, shallow mold, allowed to solidify, and is cooled in water, then folded back upon itself by hammering; no fracture being sustained, it is considered tough. This sample, with an addition of 10 per cent of copper, is melted in a small crucible, well stirred, poured again into the shallow mold, and cooled in water. When cold, it is cut in two by a shearing machine, to ascertain by its fracture whether the gold will properly alloy with the copper and retain its toughness, and if not, the toughening of the gold will have to be continued by the before mentioned reagents. The sample having proved satisfactory, the molten gold is covered with a thin layer of powdered charcoal and thoroughly stirred with a previously heated black lead spatula; then a sample is taken out by a black lead dipper and poured into a small mold. A sample from the metal in a state of fusion is always the most reliable. The metal is ladled out by means of a black lead dipper, previously heated to bright redness, into warmed and oiled molds.

When nearly all of the gold has been ladled out, another sample is poured into a small mold; the crucible is next withdrawn from the fire with a pair of stout tongs, its contents poured into a mold, with the exception of a few ounces, which are left to cool in the crucible, forming a regulus, which may contain some osm-iridium, which does not alloy with the gold, but if not removed therefrom will cause defects in the making of coin. As each mold is filled with the molten metal, a layer of powdered charcoal is strewn over its surface, as a protection from the air, until the pour is solidified. When the bars are set, they are turned out of the molds, immersed in water, and any adhering matter removed.

It naturally depends upon the accuracy of the parting process how much time will be consumed for the toughening of the gold. The fusion in a bright red fire, from the commencement of introducing the gold into the crucible to the point of being fully charged and ready for refining with niter, generally occupies from one to one and one half hours. The refining and toughening will vary from one to three hours. If the parting process has been neglected, the gold will often retain as much as ten parts of silver in one thousand. Nearly all refined gold contains some platinum, whereby also the amount of silver retained by the gold is increased. The platinum, to a great extent, is extracted by the niter and enters the slag; the latter also containing soluble salts of base metals, with some components of the crucible intermixed, as well as small shots of gold mechanically combined. These slags are pounded up and sifted to recover the larger shots of gold, and are then melted with potash, the result being a very small button which is submitted to refining with other regulus, and afterwards extracted with the alloys.

MELTING OF THE PURIFIED SILVER.

The melting of the refined silver is completed in one fusion with borax in plumbago crucibles, capable of holding four thousand to four thousand five hundred ounces of fused metal.

It is broken up in convenient pieces, the crucible is gradually but as rapidly filled as the metal subsides, the filling of which should not be retarded by waiting until the same has quite melted, but the additions are made not later at all events than the melting mass is in a pasty condition, otherwise spattering of the metal may occur. When the crucible is sufficiently filled, and the metal is in a state of fusion, some bone-ash is sprinkled over it. A small plumbago crucible cover is heated to a bright red, held by a pair of tongs, and the slag and bone-ash lightly but thoroughly intermixed, after which it is removed with this small cover into an iron dish. If the silver is plumbiferous rainbow colors appear, rapidly moving about on the surface; if a large amount of lead is present the metal fumes. If it becomes covered with a scum it likely contains iron in conjunction with copper and often sulphur. When any of these bases are present a layer of fine bone-ash is placed around the sides of the crucible whence it will float over the metal. An opening in the center is made by pushing the bone-ash with a stirrer, and niter is thrown in the opening thus made.

This layer of bone-ash gradually absorbs the oxide of the bases formed by the niter. The addition of niter is several times repeated, and the dross formed is skimmed off and retained with the first slag. The bone-ash and niter refining is repeated till the silver is of sufficient fineness.

During the refining with niter the dampers of the furnace must be closed and the furnace left partly open, for the reason that the temperature of the silver would become higher than the necessary melting point.

To ascertain if the silver is of sufficient purity a portion of the slag moved away from the center of the fluid metal by a rod or stirrer; if tl metal appears extremely brilliant, without any decided movement or tl least discoloration, such as appears so notably in cupellation, it is suf ciently fine. Here, likewise, will an experienced melter predict the finene of the metal within one one thousandth from its appearance in the crucibl

The silver is then again skimmed of its dross, a little powdered charco added, left to ignite, thereby reducing any base-oxides formed, and tl skimming repeated with additions of charcoal, until the metal presents clean, bright surface.

The metal is then covered with a thin layer of charcoal dust, and left t tranquillize for a short time. Should the temperature of the fire hav become too low and the silver having lost its decided movement, the damp ers are opened prior to the last skimming of the slag, the crucible afte wards covered and the furnace door closed, which rapidly increases th heat to the proper temperature. Molten silver, undergoing a long trea ment with niter, frequently shows a peculiar bubbling, which seems una voidable. Should the bubbling of the silver continue, repeated stirrin with a black lead spatula must be resorted to, keeping the metal covere with charcoal dust, till the bubbling has ceased. If this metal, while i a bubbling condition, should be poured into a mold, it would very likel at the point of solidification, sprout at the surface into most minute part cles; if covered by a heavy lid heavier effervescence follows, lifting th cover. In this case the bar is not marketable. The minute particles a often carried quite a distance from the mold, accumulating in sufficie quantity to be swept up. The cause of this is difficult of explanatio though it might be attributed to long refining with niter; the silver bein constantly covered may occlude some of the oxygen of the niter, more s in the presence of copper.

The time occupied in making a silver melt is generally one and one ha hours, and the refining with niter from one half hour to three hours, depend ing upon the amount of base metals present.

To make the resulting bars presentable for the trade, smooth rectangula iron molds, capable of holding from one thousand two hundred to on thousand four hundred ounces, are smoked in a chamber by burning resi or turpentine.

When the silver in the crucibles has been treated as just described, and the necessary fineness acquired, the mass is thoroughly stirred; the cruci ble with its contents is then withdrawn from the fire by first drawing a ba from the grate on each side of the crucible, forcing the fuel into the ash pit. A pair of clasp tongs connected by pulleys to a crane is then made to encircle the crucible at its middle. The crucible is thus lifted out o the furnace, and the metal cast into the smoked mold by a workman hold ing the end of the clasp tongs and tilting the crucible. Another ma retains the pulley chain to assist in its guidance; a third removes the charcoal from the spout of the crucible by means of a stick, so as to rende a clear stream of the metal. Each mold, when sufficiently filled, is covere with a closely fitting iron lid. The crucible, emptied of its contents, i returned to the furnace, the iron bars that were withdrawn replaced, and the ignited fuel taken from the ash-pit, thrown into the furnace around th crucible, which is again charged with more silver. A crucible, if carefull handled, serves for about twelve charges, and if it has not been subjecte to excessive uses of niter, may even be oftener used.

During the pouring of the metal (each crucible charge making thre bars) two samples are taken and poured into a small mold, one from the fir

and one from the last pouring. The samples (for the assay of the metal) are stamped with the same number as the corresponding bars. Sometimes the metal is bailed from the crucible by means of a plumbago dipper, without having to disturb the grate bars, into a smaller crucible previously heated to a bright red, capable of holding sufficient metal for a bar at one time. This smaller crucible is placed in a carrier, which, upon lifting the crucible, retains it below the center. To the ends of the carrier cross-bars are welded on. When the crucible is about two thirds full two men lift the crucible, tilt it, and pour the metal into the mold by means of the carrier, thus repeating until the three bars are cast from each crucible, and in every other respect following the principles as recorded above.

When the bars have solidified they are turned out of the mold, and immersed in water slightly acidulated with sulphuric acid. These fine glossy appearing bars are weighed and stamped.

The bars, when manipulated as above described, average nine hundred and ninety-eight fine, the standard of the trade being nine hundred and ninety-seven and one half fine, and they are generally exported to the Indies and China. This silver could be refined to a fineness of nine hundred and ninety-nine to nine hundred and ninety-nine and one half, which, however, is not desirable, as the mints make no allowance for such fine silver, the standard for commercial purposes being nine hundred and ninety-eight fine.

When the fine silver is to be operated upon for coinage, it very seldom has to be refined upon melting, especially when obtained by the sulphuric acid process, the base chiefly consisting of copper, which is the alloy for the coin; the silver, unlike the gold, generally being sufficiently tough, though some lead may be retained. All silver coin contains some lead.

The crucibles, as in the first place, are charged with the silver, with the addition of a little borax, and after being skimmed clean, the contents are bailed into warmed and oiled molds, holding about eight hundred ounces each.

It is requisite to always keep the silver covered with charcoal dust, to prevent its volatilization by free contact of the air. Each melting, including the pouring out, will occupy about two hours. The necessary assay samples are here likewise taken.

REDUCTION OF THE DROSS IN MELTING GOLD AND SILVER.

The slag resulting from the silver melting is fused in old crucibles, either with potash or with a large portion of borax, which in both cases will form a regulus in the bottom of the crucible; or it is melted with litharge and borax, or glass, forming a regulus, which is afterwards cupelled.

All the regulus obtained from the various processes are melted into a bar and assayed, to check the account of each manipulation. After this they are remelted into larger bars and supplementarily refined, for the purpose of again extracting with fresh alloys.

All the old crucibles, the slags, the ashes of the fuel, the dross and ends of the furnaces, sweepings, etc., are finely pulverized in a chili mill, consisting of two castiron grinding rollers of twenty-eight inches in diameter, each having a twelve-inch face. The pan thereof, revolving twenty-four times per minute, is made of castiron four and one half feet in diameter, with a rim attached of six inches in height and one inch in thickness. The pan has a die two inches thick.

After the material has been ground it is sifted, whereby any shots of metal are recovered, and the pulverized material is further treated in

amalgamators to recover a further amount of precious metals. The ings hereof are concentrated, the concentrations dried in large ovens, sold, to be smelted at lead works. The melter and refiner is credited these savings.

The shots of metal obtained from the sifted "sweeps" are associated a large amount of iron; they are melted when a suitable quantity is tained in an old crucible, with an addition of borax, and treated, to ob a regulus, with sulphur, as before described for treatment of gold wi large percentage of iron.

The amalgam is retorted, melted, and treated in like manner with phur to convert the iron into sulphide, by which means in both cas regulus is obtained of very fair metal, with iron sulphide on the surf which, after cooling, is readily detached. During the year, by the descr process, a great deal of base bullion, containing a large proportion of l is accumulated. This is finally treated in a reverberatory cupel furn producing an alloy of fine gold and silver.

SEPARATION OF ALLOYS RICH IN COPPER.

Alloys very rich in copper are melted and then granulated. T granulations are placed on the hearth of a reverberatory furnace. hearth, in place of bricks, is composed of heavy iron plates, whereby u heating the copper becomes superficially oxidized. The mass is then w drawn from the furnace, and thrown into large, leaden vessels, and bo with sulphuric acid of 20 degrees Baumé, with repeated stirring, to diss the oxide of copper formed in the furnace. The copper solution is sipho into a vat below, and the remaining granulations are washed on sieve remove the adherent acid, and these sweetened granulations again su ficially oxidized in the furnace.

This process must be repeated several times. The first copper liq are used to dissolve the oxide of copper till they are 30 degrees Baum

Some silver will eventually become oxidized, but not till nearly all o copper has been extracted. The sulphate of copper solutions are trie silver by reaction with salt. Upon concentrating the copper solution to degree for crystallization, scrap copper is added, thereby reducing any ver present to its metallic state.

The concentrated copper solution is allowed to stand until clear, ar then run off into vats for crystallization. The sediments remaining gathered and treated in the usual manner, and finally melted.

The alloy remaining and containing very little of its original copp next treated with boiling concentrated sulphuric acid, provided the pr proportion of silver and gold was found by assay in the original co alloy, and proceeded with as parting on the large scale with alloys. however, there is not sufficient silver present in the alloy, it is melted additions of niter, and the resulting argentiferous gold submitted to extraction process.

This method is adopted to save the large amount of sulphuric aci volved if such alloys are treated direct with concentrated sulphuric as the dilute acid readily dissolves the oxide of copper, without the w age of the sulphuric acid.

CHLORINE PROCESS.

SEPARATION OF SILVER FROM GOLD IN THE MOLTEN STATE BY CHLORINE GAS.

In 1838 Mr. L. Thompson investigated the action of chlorine gas in the separation of silver from gold while in the molten state, the result of which he presented before the Society of Arts of England, who printed such in 1840, in which he states:

That not only has gold no affinity for chlorine at red heat, but it actually parts with it at that temperature, although previously combined; that is to say, the chloride of gold is reduced to its metallic state by heat alone, and it cannot, therefore, possess any affinity for chlorine when red hot. This, however, is not the case with those metals with which it is usually alloyed. It offers, therefore, at once an easy and certain means of separation.

The application of these facts is all, therefore, to which I can lay claim, as the facts themselves have been known for many years, and the reasons why they have not so been applied is, that hitherto chemists have not directed their attention to this art, but have left it entirely in the hands of the assayers, who are, for the most part, ignorant of chemistry.

Mr. B. F. Miller, assayer of the Sydney Mint, Australia, in 1867 practically applied this treatment for the separation of the silver from the gold while in the molten state, it being the most economical process they could there apply, owing to the high price of acid in that country, as well as the most important feature of having no crude silver for the "acid parting process." Even in having a supply of fine silver on hand, which, after each refining, would have to be again treated with crude gold, the expense of such process is large, the refining charges of crude silver being lost to the metallurgical works. Such was the case frequently at the San Francisco Mint, prior to the large yield of silver from the Comstock.

Miller's process is patented both in the United States and England, and has been successfully used in the Royal Mint of London, by Mr. Roberts Austin, in "toughening" extremely brittle gold in a comparatively short time, and in a more economical manner than that with corrosive sublimate. Mr. Miller describes the process as follows:

The furnace required for this operation is the ordinary melting furnace, with the flue as near the top as possible, so as to allow of the crucible standing high up in the furnace, without being cooled by the draught, and of such a depth that the bottom of the crucible, when it is placed in the fire, is not more than three inches above the grate bars. The furnace is generally twelve inches square.

The covering of the furnace consists of two fire tiles, seven and one half inches long and fifteen inches long, one of which has a slot or hole in the center to allow the chlorine tubes to pass through. An iron cover would become too hot for the convenience of the workmen.

The crucibles employed for the refining are the French white fluxing crucibles. They are fitted for use by filling them with boiling aqueous solution of borax, letting it remain therein for ten minutes, then pouring it out, and afterwards drying them. The crucibles thus prepared are heated to redness, whereby the borax forms a glaze on their inner surface, thereby rendering them impervious to the infiltration of the very liquid chlorides of silver.

When used for refining they are placed within black lead crucibles as a precaution against loss, should the furnace crack, which, however, seldom happens.

The crucibles are covered with loosely fitting lids, with the requisite holes through them for the passage of the clay chlorine pipes, etc. Ordinary clay tobacco pipe stems, one half inch in diameter, twenty-two inches long, three sixteenths inch bore, have been found to answer well for the purpose of passing the gas through the molten gold. (Pipes are now expressly furnished for this purpose by the Battersea Crucible Works in England.)

Two pipes are used at a time in one crucible.

Before immediate using, the lower end of the pipe should be heated for about ten minutes; if not, it is liable to split.

The chlorine generator consists of the best stoneware acid jars, capable of holding ten to fifteen gallons, and furnished with two necks. One of these openings is stopped with a vulcanized india rubber plug, through which two glass tubes pass tightly—the eduction tube, and the safety or pressure tube, the length of the former being a few inches, and the latter from eight to ten feet.

The other opening is intended for introducing oxide of manganese, etc., and is closed with a leaden plug, covered with a stout piece of india rubber, and well secured.

On the bottom of the generator is placed a draining layer, so called, of small quartz pebbles, down nearly to the bottom of which the pressure tube should extend. On this layer should be placed from seventy to one hundred pounds weight of binoxide of manganese in grains, in pieces of about one quarter inch cube, sifted from powder. This quantity will be sufficient to effect many refining operations, and will obviate the necessity of repeated dismantling of the apparatus.

Each generator should be suspended to about half its height in a galvanized iron water bath.

The chlorine gas is produced, when required, by pouring common hydrochloric acid down the safety tube, the apparatus being warmed by means of gas burners beneath the water baths.

The gas is conveyed from the generators by means of a leaden pipe fitted with branches to supply the several furnaces, all intermediate connections being formed by means of vulcanized india rubber tubing, which, if screened from direct radiation from the fire, stands the heat well, even immediately over the furnace.

All joints between the various pipes and india rubber tubes are easily secured and rendered perfectly gas tight with a cement consisting of a thin solution of india rubber in chloroform.

Screw compression clamps on the india rubber tubes give the means of regulating the supply of gas as required, and enable the operator to shut it off entirely as soon as the refining is over. The chlorine then, having no means of escape, accumulates in the generator, and soon forces all the acid up the safety tube into a vessel placed above to receive it; and the acid no longer acting on the oxide of manganese, the supply of gas of course ceases. Two such generators as are here described, and three ordinary gold-melting furnaces, have been found capable of refining daily about two thousand ounces of gold, containing about 10 per cent of silver, between nine A. M. and two P. M.

The French crucibles, say size seventeen or eighteen, duly prepared with borax, having been placed in the cold furnace and slowly and carefully heated to dull redness, the gold, from six hundred to seven hundred ounces to each crucible, is introduced and the fire urged until the metal is melted, the necessary generation of chlorine having meantime commenced by the introduction of a little hydrochloric acid poured down the safety tube into the generators.

As soon as the gold is melted, from two to three ounces of borax, in a state of fusion, are poured upon its surface. If the borax is added sooner it acts too much on the lower part of the crucible, and if thrown in cold is apt to chill the gold. The clay pipe, which is to convey the chlorine to the bottom of the molten gold, is now introduced. At the moment of its entering the molten gold, the screw compression clamp is slightly loosened, so as to allow a small quantity of gas to pass through it, and thus prevent any metal rising and settling in the pipe, which is then gradually lowered to the bottom of the molten gold, where it is kept by means of a few small weights attached to the top. The compression tap is now quite relaxed, and the gas is heard bubbling up through the molten metal, which it does quietly and without projection of globules from the pot.

Sufficient hydrochloric acid must be added to the generators from time to time to keep up a rapid evolution of chlorine. The column of liquid in the safety tube, acting as it does like a barometer, affords a ready means of knowing the pressure in the generator, and of judging of the rate of production of the gas, as well as at once showing by its fall if anything irregular has occurred, such as a leak or a crack of the chlorine pipe or crucible. From sixteen to eighteen inches in the safety tube correspond to and balance one inch of gold in the refining crucible. When the chlorine is first introduced into the molten gold, a quantity of fumes is seen to pass up from the holes in the crucible lid; these are not chloride of silver, but the volatile chlorides of some of the baser metals, and they are especially dense when much lead is present in the alloy under treatment, forming a white deposit on any cold substance presented to them. After a time, longer or shorter according to the impurities in the gold, the fumes cease. So long as any decided quantity of silver is present in the molten gold, the whole, or nearly the whole, of the chlorine is absorbed, little, if any, appearing to escape and to be thus wasted, and it is found that the better the supply of chlorine, the quicker is the operation. It is essential in using chlorine that the gas should pass to the very bottom to effect a complete refinage.

As soon as the operation is nearly over, fumes of a darker color than those observed at the commencement make their appearance, and the end of the refinage is indicated by a peculiar flame or luminous vapor of a brownish-yellow color, occasioned by the free and now waste chlorine escaping, which can be seen on removing a small plug which fits into a hole in the lid of the pot. This, however, of itself is not a sufficient indication. The process is not complete until this flame imparts to a piece of white tobacco pipe, or similar substance, when held in it for a moment, a peculiar reddish or brownish-yellow stain; so long as it gives any other color, the refinage is unfinished.

When these appearances are observed usually for gold containing about 10 per cent of silver in about an hour and a half from the introduction of chlorine, the gas is shut off and the crucibles removed from the fire; the white crucible lifted out of the black one, and, together with its contents, allowed to stand for several minutes, until the gold becomes cool enough to set or solidify. The chloride of silver, which remains liquid much longer, is poured off into iron molds. The crucible is then inverted on an iron table, when the still hot gold falls out in the shape of a cone. This is slightly scraped and thrown

hissing into a concentrated solution of common salt to free it from any adherent chloride of silver. An alloy containing originally 89 per cent of gold, 10 per cent of silver, and 1 per cent of base metal, will yield, on an average, a cake of chloride weighing, with a little adherent borax, fifteen ounces for every one hundred ounces operated on.

It is necessary to very carefully dry and heat the molds into which the chloride of silver is poured, as the slightest moisture causes the latter to be violently dispersed, to the great risk of the bystanders.

The gold is now fine, and simply requires melting into ingots.

As before stated, it is found that all these operations can readily be performed, and about two thousand ounces refined per day in three common melting furnaces, in five hours; 98 per cent of the gold originally contained in the alloy operated on is then ready for delivery. The other 2 per cent remains with the chloride of silver, partly in the metallic state and partly in a state of combination with chlorine, and probably with silver. To free the chloride of silver from this combined gold it is melted in a boraxed white pot, with the addition of from 8 to 10 per cent of metallic silver, rolled to about one eighth of an inch in thickness. The chloride of gold is by this means reduced at the expense of the metallic silver, chloride of silver being formed, while the liberated gold sinks, and melts into a button at the bottom of the pot. As soon as the whole is thoroughly melted the crucible is removed from the furnace and allowed to stand about ten minutes, and the still liquid chloride of silver is then poured into larger iron molds, so as to form slabs of convenient thickness for the next operation, that is, the reduction to the metallic state.

After the fusion of the chlorides a small quantity of a curious spongiform substance adheres to the sides of the crucible used, probably consisting of subchloride of silver; but since it always contains a little gold, care has to be taken in pouring off the fluid chlorides to prevent this auriferous sponge from falling out and mixing with them. The slabs of chloride of silver are reduced without difficulty by plates of wrought iron or zinc in the usual way.

Besides the separation and recovery of the silver, as above described, another useful end is gained by this process—that of having converted the "brittle" into "tough" gold.

In the metallurgic treatment of the precious metals, some loss is always sustained; but that, in the process here described, is found very small. The average loss of gold in operating hitherto has been found to amount to nineteen parts in every one hundred thousand of alloy treated, which is considerably less than would be met with in toughening an equal amount of gold with corrosive sublimate in the ordinary manner. The loss of silver has amounted to two hundred and forty parts in every one hundred thousand of alloy operated on (containing originally, say 10 per cent of silver). There is no doubt that a considerable portion of both these losses would be recovered on further treating the crucibles and ashes remaining after the operation. In refining, on the large scale, gold containing 10 per cent of silver, the cost of the operation in Sydney is about 5 farthings per ounce. The fineness of the gold produced by this process varies from nine hundred and ninety-one to nine hundred and ninety-seven in one thousand parts, the average being nine hundred and ninety-three and one half. The remaining six and one half thousandths are silver, and this compares favorably with any of the previously known practical processes.

The silver resulting from this method of refining is tough, but its quality varies somewhat according to the gold originally operated on. If the alloy treated contains much copper, the greater part of this remains with the resulting silver, but the other metals are nearly all eliminated.

The fineness of the silver hitherto obtained has varied from 918.2 to 992 in one thousand parts, the average being 965.6. Analysis of the silver resulting from the refinage of gold, known originally to have contained, among the base metals in the alloy, copper, lead, antimony, arsenic, and iron, gave the following results:

Silver	972.3
Copper	25.0
Gold	2.7
Zinc and iron	Traces.
	1000.0

REDUCTION OF THE CHLORIDE OF SILVER OBTAINED BY "MILLER'S" PROCESS.

In a paper subsequently read before the Royal Society of Victoria, Dr. A. Leibius, assayer to the Sydney Mint, described a new apparatus for the reducing of the chloride of silver obtained by Miller's chlorination process. He describes his process as follows:

In 1868, Messrs. De la Rue and Hugo Miller, in London, constructed a galvanic battery, one pole of which consisted of fused argentic chloride the thickness of a goose quill, the other pole of cylinders of zinc. Adopting this principle, I have endeavored to construct an apparatus which should fulfill the requirements before referred to.

After operating successfully with a small model, which allows the reduction of about two hundred and fifty ounces of argentic chloride in one operation, I have, with slight modifications, constructed an apparatus which will reduce from one thousand four hun-

dred to one thousand five hundred ounces of argentic chloride in twenty-four hours. The apparatus and its dimensions are as follows:

Two thick boards, fifteen inches long, are joined together on both ends by three strong battens, so as to form an open box without a bottom, thirteen inches long by fourteen inches wide, and fifteen inches high (inside measurement). The two boards forming the length of the box or frame contain seven vertical grooves, one half inch wide, and one half inch deep, at intervals of one and one half inches from each other. These grooves are cut down to a length of twelve inches, leaving three inches of each board forming the legs of the frame.

At the termination of these grooves passes horizontally a narrow slit, one half inch deep, and along the whole length of each board, into which a strip of metallic silver, one half inch wide and the thickness of about a three-penny piece, is tightly fixed, projecting on one side of the frame about eighteen inches beyond each board.

The seven grooves, already alluded to, are for holding zinc plates, one half inch thick, fourteen inches long, and twelve inches high, which rest on both sides on the strips of silver, which, as just described, are jammed horizontally into the sides of the two boards. A connection is thus established between the seven zinc plates and these strips of silver.

The second part of the apparatus consists of a wooden frame, cut out of a solid board one inch thick, and supplied with two large iron handles. This frame is the same length as the box holding the zinc plates, but three inches narrower. It contains, on each side, parallel to the direction of the zinc plates, twelve slits, one half inch long, which hold silver bands, one half inch broad and the thickness of a three-penny piece. These silver bands are passed through the slits in the board, so as to form on each side of it six loops, eleven and one half inches in length and seven eighths of an inch wide. The six loops on one side are exactly opposite to those on the other side of the boards, at a distance of about nine inches. They are intended to hold the slabs of argentic chloride, which are twelve inches long, ten inches high, and about three fourths of an inch thick, and are put through these loops lengthwise, projecting on each end about one inch beyond the silver bands.

The whole frame holds, as before stated, six of these slabs of argentic chloride, which are placed between the six spaces formed by the seven zinc plates, from which latter they are about one quarter inch apart on each side.

The projecting horizontal strips of silver jammed into the sides of the lower frame are then connected with the ends of the silver forming the loops in which the argentic chloride is suspended, and the whole apparatus, thus charged, is placed in a tub filled with water. After a short time galvanic action is discernable, the liquid gets gradually warmer, and a strong galvanic current is observed. After about twenty-four hours the action has nearly ceased, and the whole argentic chloride is found to be completely reduced to metallic silver, which retains in the silver loops the same shape, and outwardly also nearly the same appearance, as when first introduced as argentic chloride. The latter contains always more or less chloride of copper (eliminated, together with the silver, during the operation of refinage by chlorine), which is reduced together with the chloride of silver; in fact, this soluble chloride of copper helps to act as an exciting liquor for the battery. In the first experiments a weak solution of salt (chloride of sodium) was used as exciting liquor, but it was found that this could be dispensed with, and only common water used. The action, however, is, in this case, a little retarded, and does not become powerful until about two hours after the battery is set. By using a part of the resulting liquor from a previous reduction of argentic chloride, and which contains chloride of zinc, it has been found that the galvanic action sets in very rapidly, and accelerates thereby the completion of the reduction.

No acid is used; and, therefore, the amount of zinc used in each reduction has invariably been found to be almost the theoretical quantity required to combine the chlorine of the argentic chloride treated with the metallic zinc, in order to form chloride of zinc. The quantity of metallic zinc thus used was always from 24 to 25 per cent of the weight of the argentic chloride reduced.

The reduced silver is boiled out in acidulated water, in order to remove the basic and oxychlorides, and finally in pure water, while still suspended in the silver loops. As soon as it is taken off the last boiling, it is immediately ready for the melting pot, since the heat from the boiling water dries the porous mass of silver sufficiently to allow of its immediate melting. The seven zinc plates, when first used, weigh about one hundred and forty pounds avoirdupois; the six slabs of argentic chloride of the dimensions already given, weigh about one thousand four hundred ounces troy.

The zinc plates are used over again, until too thin for that purpose, when they are remelted and cast into new plates. It has been found that the quantity of zinc used is little, if at all, increased by prolonging the time of connection with the silver plates after the reduction is completed; the whole apparatus, when once set in operation, can, therefore, be left to itself until it is found convenient to melt the reduced silver.

While this apparatus reduces the argentic chloride much quicker than if the latter is simply placed in contact with zinc or iron plates, it obviates any handling of the argentic chloride from the time the latter has been placed in the silver loops until the reduced silver is ready for the melting pot, advantages which have been fully appreciated by those who formerly had to resort to tedious and disagreeable manipulations.

COINAGE AT THE MINTS.

The supervision of the mints by law is committed to one principal officer, named the Director, who is under the general control of the Secretary of the Treasury. The operation of each mint is divided into several departments, such as: receipts and disbursements, assaying the precious metals, including the primary melting for assays, melting and refining for coinage, coining in all its branches.

It is regulated by law that the gold bullion brought to the mints for coining shall be received and coined by the proper officers, for the benefit of the depositors; and that it shall be lawful to refuse at the mints any deposit of less value than $100, and any bullion so base as to be unsuitable for the separation. The gold bullion is received by the proper officer, who weighs it in the presence of the depositor, records the transaction with its description, and gives a receipt; the hours for such receival being from nine to twelve A. M., daily, Sundays and holidays excepted. The deposit is at once sent to the deposit melting room, melted under the supervision of the Superintendent by proxy, who also records the transaction, together with the nature of the gold deposit; it is then re-weighed in the receiving room and assayed without delay. The exact mint value is determined, and upon the following day the depositor receives a warrant drawn on the cashier for payment of his deposit in coin, deductions being made according to the following tariff of charges:

Deposit and Melting Charge.

On all bullion (or coin) not required to be parted or refined:

For each melt of 1,000 ounces, or less	$1 00
For each melt over 1,000 ounces	One tenth of 1 cent per ounce.

Parting and Refining Charges.

1. Parting Gold and Silver or Refining Gold—Rate per Ounce, Gross.

Bullion containing less than 200 M gold	2 cents.
Bullion containing from 200 M to 399½ M gold	3 cents.
Bullion containing from 400 M to 699½ M gold	4 cents.
Bullion containing from 700 M and over gold	6 cents.
Bullion containing over 100 M base metal, additional	½ cent.

And, in addition to the above, on deposits requiring parting (except silver purchases) or refining gold:

For each deposit of 1,000 ounces, or less	$1 00
For each deposit over 1,000 ounces	One tenth of 1 cent per ounce gross.

For gold coin or standard gold bars the rate per ounce charged will be imposed only on the number of ounces required to be refined to raise the whole to standard.

Silver allowed the depositor is calculated on the basis of refining the gold to 990 M.

2. Refining Silver—Rates per Ounce, Gross.

Bullion containing less than 897 M silver	2 cents.
Bullion containing 897 M to 979½ M silver	1½ cents.
Bullion containing 980 M to 997½ M silver	1 cent.

In addition to the above, on silver deposits requiring refining (except purchases) a charge on each deposit of—

1,000 ounces or less	$1 00
Over 1,000 ounces	One tenth of 1 cent per ounce gross.

For standard or sterling bars the rate per ounce will be imposed only on the number of ounces required to be refined to raise the whole to the fineness of such bars.

Silver bullion below 997½ fine, not containing gold, deposited for fine bars, is subject to a refining charge. Silver bullion, deposited for bars, will be computed at $1 per standard ounce. Silver parted from gold deposits will be purchased at the rate fixed by the Director of the Mint, which at present —— per ounce standard.

TOUGHENING CHARGE.

Gold bullion	½ to 2 cents per ounce gross.
Silver bullion	¼ to 1 cent per ounce gross.

ALLOY CHARGE.

On the number of ounces of copper required to reduce the bullion to standard, 2 cents per ounce, troy.

BAR CHARGE.

On bullion deposited for fine bars not required to be parted or refined, and for standard, sterling, or unparted bars:

Bars of fine gold, per $100 value	10 cents.
Bars of standard gold, per $100 value	10 cents.
Bars of fine silver, per ounce fine	¼ cent.
Bars of standard silver, per ounce standard	½ cent.
Bars of sterling silver, per ounce gross	⅛ cent.
Bars of unparted bullion, per ounce gross	½ cent.

No deposit of bullion is received of less value than $100, or so base as to be deemed unsuitable for the operations of the mint.

Since the free coinage of silver has been abandoned, the mint receives silver bullion for parting only, returning to the depositor, after the completion of such parting, fine silver bars, for the value of the silver, and coin for the gold that such bullion may have contained, deducting the charges for parting, etc.

The exception to the above being the purchase of silver by the Government to cover the amount of silver coinage per month, as provided for by the "Bland Act." By said Act the silver bullion is purchased by the Superintendent for the Government at the market rates, which are governed by the daily London quotations, allowing for the variation in exchange.

The gold or silver employed for being coined into money is invariably alloyed with copper, and it is enacted that the United States coin shall consist of nine hundred parts of either the gold or silver and one hundred parts of copper in one thousand parts.

The English standard of the alloy is in the proportion of twenty-two parts of either of the pure precious metals to two parts of copper. The basis of silver bullion valuation is sterling, containing 11 oz. 2 dwts. of silver and 18 dwts. of alloy in the troy pound, and assays are there reported as "better" or "worse" than standard in dwts. per pound, according to the excess or deficiency of alloy; the corresponding millesimal fineness is 925 silver and 75 alloy; therefore, 75÷18=4⅙ per 1,000, is equivalent to 1 dwt. per pound; as, for instance, our coin is 900 silver and 100 alloy, is 100—75 =25 per 1,000, or 6 dwts. "worse."

Gold with copper forms a ductile alloy of a deeper color, harder and more fusible than pure gold.

Silver that contains 10 per cent of copper is more fusible, harder, and more suitable to friction than pure silver. It is thereby also rendered sonorous, while its color is but little impaired. Even with equal weights of silver and copper the compound is white. The maximum of hardness is attained when the copper amounts to one fifth of the silver.

All the fine gold and fine silver, as also all unparted bullion, is transferred and debited to the melter and refiner of the mint, who is held responsible for all bullion received by him until refined, cast into ingots of standard metal, and transmitted to the coiner.

MOLDING OF INGOTS OF THE ALLOYED GOLD OR SILVER.

The fine gold and fine silver is arranged by weight into distinct melts, for the proper addition of the alloy of copper, and placed in the order of their number. In accordance with the amount of gold these arranged melts contain, they are alloyed with copper, the silver by weight occurring in the fine gold being allowed for as copper, by which means the melts are brought to their standard.

These melts are taken to the gold melting room, where the furnaces have been prepared and the black lead crucibles are at a red heat for the reception of the metal.

In Europe the silver ingot melting is done in wrought iron crucibles, each capable of holding four thousand ounces.

In the crucible some pulverized charcoal is strewn, to neutralize oxidation of the copper of the alloy; a hood is placed over the furnace, through which the bars are carefully placed into the crucibles, as well as the copper alloy. By using the hood, any metal will be prevented from falling into the fire, as a small piece of copper lost would condemn the ingot melt. When the gold bars are melted, further additions are made, consisting of clippings, blanks, etc., which are returned from the coiner's department, until the crucible is about three quarters full. These clippings are made into bundles by placing them in an iron clasp, which in diameter corresponds with the interior of the crucible, and they are introduced into the metal by placing a ring of from three to four inches deep, cut out from another crucible, on top of the melting pot, by which this ring acts as a funnel, as otherwise these bundles, being about nine inches long, would project over the rim of the melting pot, and, as before fusion they become pasty, portions thereof would fall into the fire.

When the metal is in a state of fusion and the temperature deemed adequate, the surface of the metal is sprinkled with very finely pulverized charcoal. This covering tends to the reduction of any oxide of copper formed on the surface of the metal, and the charcoal is allowed to act for a short interval. The charcoal not only assists in the removal of the oxygen, but also prevents absorption of a further amount when the metal is in a state of rest. These are very important facts to be borne in mind in melting for coinage ingots, as otherwise they would be rendered brittle.

To the molten alloy a previously heated stirrer is introduced, and the whole mass is thoroughly mixed by churning the stirrer up and down for quite a time, this being one of the most essential parts of the operation, as the specific gravity of the gold is so much greater than the copper; and a perfect alloying of the metals is here accomplished, so that each and every subsequent ingot cast be of standard fineness. The metal is ladled out and poured into vertical iron molds, each dipper of metal containing two ingots. During the pouring a circular motion is given to the metal in the dipper, so as not to permit the molten mass to subside. The ingot molds are in two sections, slightly varying from rectangular, and composed of three separate pieces of planed iron, which permit of the ingots easily falling out after they are set. Each mold is bound with a clasp, tightened by a set screw. The molds are placed in an iron trough in sets of nine, at a convenient distance from the furnace, and of a height to pour at ease. The metal in the mold solidifies immediately, a workman grasps the mold, throws it upon an iron table close by, when another workman loosens the screw, by which the mold is caused to fall to pieces; he rejoins the pieces, slightly oiling the planed sides, and tightens the molds by the set screw

ready for use. This opening and closing is as rapidly performed by the workman as the melter pours into the ingot molds, which pouring, opening, and closing of the molds is continued until a certain quantity of ingots have been poured from one melting pot. Two sets of molds are used, alternating, as otherwise they would become too hot to make perfect ingots.

As each ingot is exposed it is turned into a tray, where another workman, by means of a pair of copper tongs, takes up a certain quantity of these ingots, plunging them hissing into cold water, yet retaining them with the tongs, immersing them, still hot, into a vat containing water acidulated with sulphuric acid, which operation softens and case-hardens the ingots, after which they are again dipped in water to remove the acid.

As soon as one crucible has been emptied of nearly all its contents it is refilled for another melt. The other furnaces containing similar melts are emptied of their contents, one at a time, and the above operation repeated, until all the metal prepared for that day has been cast into ingots.

The crucibles are withdrawn from the fire and the metal remaining in each crucible cast into open molds, which is used upon the following day with new melts.

After the ingots have been washed of their acid, each is placed separately in a vise, and the rough edge trimmed by filing.

From each gold ingot melt, two samples are cut for the assay; one from the first and one from the last ingot cast. These samples are taken to the assaying department, carefully weighed, put up in a slip of paper, marked with the corresponding number of the melt, and assayed. From the silver ingot melts, however, two samples are taken in the shape of granulations, one from the commencement of the pouring, and one when the last ingot has been cast. The ingots on account of their rapid solidification contract in volume and leave a hollow part (saucer shaped) on the top of the ingot. This portion of the metal is cut off by a shears, which is driven by a drum on a shaft of a driving pulley. At each revolution of the drum, the same being excentric, the shears, consisting of a vertically sliding steel jaw, in combination with a fixed steel lower jaw, are caused to open and shut. The hollow end of the ingot is placed therein, cutting off as much as the operator desires.

The weight of a melt of gold ingots averages two thousand nine hundred and fifty ounces, composed of forty ingots for the coining of double eagles, or fifty-six of eagles, or seventy-two of half eagles. The size of an ingot being twelve and a half inches long, one and three quarters inches wide, half of an inch thick for the first, one inch wide for the second, and three quarters of an inch wide for the last.

Each melt of ingots occupies about one and a half hours, including the stirring, pouring, etc.

The melting of gold ingots is not in daily operation, such depending entirely upon the refined gold produced, and when the day is occupied for such purposes from three to four furnaces are run at a time, in which from eight to twelve melts are made.

Each ingot is stamped with a distinctive number to designate the melt, so that if any error should appear the melt can be identified and the composition traced.

The silver, with its alloy, passes through the same stages as the gold.

The average weight of a melt of silver ingots is about one thousand six hundred and fifty ounces, comprising thirty-five ingots for the dollar, the same for dimes, and seventy-two for quarters, the molds being of the same dimensions as for gold, the molds for dimes the same as for the dollars. In the silver ingot melting room there are six melting furnaces, and with

three melters and their necessary assistants, thirty-six melts of silver ingots constitute a day's labor, thereby producing about sixty thousand ounces of silver ingots in a day, which is accomplished in about six hours from the time the first silver, with its alloy, is placed into the heated crucibles.

The working variations allowed in the gold ingots is not to vary each way from the standard more than one half of one thousandth, *i. e.*, 899½ to 900½ fine in gold; and the silver ingots, each way, one and one half thousandths, *i. e.*, 898½ to 901½ fine in silver.

The bona fide mechanical loss of bullion incurred in the operation by the melter's and refiner's department, and of the coiner's department, is fixed by law.

The necessary wastage allowed, with the approval of the Superintendent, is, in the case of the melter and refiner, not to exceed one thousandth of the whole amount of gold and one and one half thousandths of silver of the whole amount operated upon, and in the case of the coiner one half thousandth of the gold and one thousandth of the silver of the whole amount operated upon from annual settlement to settlement, at which time the annual clean-up is made, being a most thorough one, covering the receipts of all the residue.

The floors of the melting room in the mint are composed of flagstones, covered with hexagonal castiron gratings of one foot in diameter, having one inch round holes.

As soon as the melts are completed, the sections of iron are removed from the floor proper, from such places where there is any likelihood of metal having dropped, and the floor is carefully swept. The sweepings are vanned and the recovered grains dried.

The ingot melts are taken to the melter and refiner's room, where each melt is weighed; the weight is registered in the day-book, and at the end of the day the surplus assay clippings, sweeping grains, filings, and residue bars, are added to the amount of the ingots, so as to show the apparent waste that has taken place. The ashes and cinders from melting the gold ingots, or those of the silver ingots, are ground up, and at the close of each month are cast into a bar and credited to the ingot account, gold or silver.

The ingots are locked up in the melter and refiner's vaults, and remain there until such time as the assay trials have been made and an order for delivery on the coiner transmitted. This being done, they are sent to the office of receipts, weighed in the presence of the proper officers, and a receipt there given to the melter and refiner by the coining department. On the other hand, when the melter and refiner receives clippings, blanks, and other pieces of metal from the coining department, he gives a receipt therefor to the coiner.

Seven twelfths of the ingots is the amount of good coin produced, minus the ends cut off, including all hollow, brittle, or badly melted ingots; consequently the amount returned to the melting department should not exceed five twelfths. Any amount over five twelfths of clippings, etc., returned is to the prejudice of the melter, as by carelessness or indifference of interest displayed by the melters this amount is liable to be larger, by which naturally the expense of coinage is increased.

Upon the reports of the assays proving satisfactory, the ingots are delivered as above described for coinage, condemning, however, such melts as are found to deviate from the standard beyond a certain amount. These are either remelted, with some addition of alloy or fine gold, or simply combined, melted, thoroughly stirred, and cast into ingots.

The ratio of condemned melts of gold and silver ingots is in none of the mints large, of which the San Francisco Mint has produced the best record.

THE ALLOY OF THE REFINED METALS.

The copper employed for alloying purposes is of the very best grade froı Lake Superior, refined at Baltimore, Maryland. Its fineness is nine huı dred and ninety-nine and seven tenths, the remaining three tenths consis ing chiefly of iron.

It is the practice at some mints to remelt the copper for the purpose (subdivision, as well as for the convenience in making up the ingot melt The copper in this case is melted in plumbago crucibles, and when it is i a proper condition for removal from the furnace it is cast into a series o small molds (previously oiled), arranged along the side of the furnace As soon as the copper has solidified in the molds, it is turned over to th edge of a water tank, and with a smart shock the small slab of copper i thrown into the water, by which the oxide of copper formed on the face o the slab, during the momentary cooling upon settling, is removed. Th remelting of the copper, unless skillfully accomplished, renders the coppe brittle. No charcoal dust is used on the molten copper, as it would becom "overpoled." In case the latter takes place the molten copper must underg a short exposure to the oxidizing influence of the atmospheric air.

The pouring must be effected at a high heat, as the metal chills ver easily in the crucible, and must be executed with the least possible delay since it would otherwise be liable to again become somewhat "dry" throug the absorption of oxygen, rendering it brittle, in which case some charcoa must be added, which tends to the reduction of the oxide formed, allowin the charcoal to act alone for a short interval. But if too dry, "poling' must be resorted to with a pole of green wood, by which copious gases ar evolved, and the reduction of the oxides is rapidly completed. This "pol ing" also prevents the further absorption of oxygen while in a state of res The surface of an ingot of tough copper is almost level; if impure it sink into a furrow or rises into a ridge.

In concluding with the melting and refining department it may be we to state that in some mints the Reichhelm gas cupel furnaces have bee introduced, in which the work is satisfactorily conducted, and it is but mere question of little time when gas furnaces will be in operation for th melting of the precious metals, the preference for which is clearly perce tible.

THE COINAGE OF THE PRECIOUS METALS.

Coinage is the act of fabricating money. In the departments of th coiners of the mints the gold and silver ingots received undergo near the same operation. For this reason a description of one will suffice for al nor in such description is any one particular mint referred to, but a sun mary of all, endeavoring to illustrate their methods combined in on The ingots are weighed by the transfer clerk, in presence of a clerk of th melter's department and the receiving clerk of the coiner's departmen by which manner the accounts are checked, and are delivered into th coiner's office. A tag is placed on each set, and they are next conveyed t the rolling room, where they are subjected to flattening and laminating.

THE ROLLING OF THE INGOTS INTO FILLETS.

The rolling room contains several sets of rollers, large and small one composed of break-down and finishing rollers. The rolling mills aı driven by geared pulleys, receiving their power from the main drivin shaft and pulley, which drives a shaft and adjusting couplings of the roll

The pressure of the rolls varies as to the size of the rolling mill, as for the first break-down rollers the pressure being about eighty tons. These rolls are generally made of chilled caststeel, with a face about twelve inches long and eight inches in diameter, to which the gudgeons are cast solid. Each roll is driven independently by its own pulley in opposite direction. The boxes of the journals are made of brass, of which the lower half is provided with babbitt metal gibs, extending to the full length of the bearing portion.

The limit of play between the rolls is regulated by the action of a lever, which gives motion to screw wheels on top. Below these screws, cups are attached, which rest on the upper brasses of the journal of the roll, by which means the upper brasses are always against the end of the screw. The contrivance, therefore, is such that the upper roll alone has an upward and downward, as well as its revolving movement, the lower roll revolving simply on its axis. The speed of the rolls is about eighty revolutions per minute, and are driven by a pulley five feet in diameter with a ten-inch face.

The distance required between the rolls is arrived at with the utmost precision by a steel instrument, which is attached to the mill by a clamp, which has the appearance of a hollow wedge, and indicating by a gauge thereon the distance of the opening of the rolls.

The ingot is placed on a lateral guide, such being attached to the feed side of the mill, where it is bitten by the rolls, dragged forward and passed through to where they fall on the discharge side upon flat guides, preventing any flexure of the passing ingots. In this manner each ingot of a set is passed through the roll, and as the rolls were set by the gauge, described above, the first rolling merely compresses the ingots.

The rolls are now adjusted by the screws, set by the gauge, by which any further upward motion of the top roll than required becomes impossible, and the ingots are again passed through the rolls. The rolls are again reset, and the rolling goes on until each ingot has passed through several times at varying pinches, until they have assumed the desired thinness for passing through the breaking-down mill, the ingots having reached a length of about three and one half feet, by which means the now termed "fillets" retain a nearly uniform thickness. A continued rolling causes the fillets to become thicker in the middle than on the sides. The rolling, however, does not increase the width of the fillets to any perceptible degree, for the reason that the decrease of thickness is proceeded with by gradual pinches of the adjusting screws.

The fractured ends of the fillets are removed by a cutting press, similar to those in the melting room heretofore described.

ANNEALING OF THE FILLETS.

After the shearing the fillets are transferred to the annealing room, as by continuous rolling without annealing they become hard and brittle, making them liable to crack at the edges, which would seriously interfere with the subsequent operations.

In the annealing room there are several reverberatory furnaces, all of the same size and character. They are built of common brick, lined with firebrick, held together by heavy castiron frames. Heavy castiron doors about one foot square are attached, the fire chamber being about eighteen inches high, the furnace hearth five feet and nine inches long and fourteen inches wide, the wood fire being regulated by dampers. In front of the working door an iron carrier, resting on an iron bench attached to the furnace, is placed.

The sheared fillets are placed in copper tubes of three sixteenths of a inch in thickness, three feet ten inches long, and four and one quarte inches in diameter; each tube will hold from twenty to twenty-five fillet These tubes are made without solder. The annealing is accomplished a a high degree of heat.

The tubes, containing the fillets, are capped and luted with pipe-clay placed upon the carrier, and run onto the hearth of the furnace. Th doors are closed, the dampers opened, and the heat raised to the annealin point, which is left to the judgment of the workman. The annealing wil be completed in about twenty-five minutes, the utmost care being exercised that the heat is equally distributed, as well as occasionally turning the tubes over. The fillets, so inclosed from the atmospheric air, prevent the oxidation of the copper with which they are alloyed, for should such take place it would render the subsequent coin above standard.

As soon as the annealing is completed, the dampers are lowered, the working door raised, and the carrier pulled out onto the stand. The tubes are removed from the carrier by iron tongs and immersed in rectangular copper-lined vats; the caps, after a few minutes, are removed, whereby the tubes fill with water.

The fillets are now removed, cleansed in acidulated water, rinsed in water, and dried with cotton cloths.

This mode of rapid cooling is resorted to to prevent the access of th atmosphere, as prolonged and open cooling facilitates the absorption o oxygen.

ROLLING OF THE ANNEALED FILLETS.

The fillets are now returned to the rolling room, and are passed repeatedly through the breaking-down mill with what is termed a "spring pinch, as in the previous rolling they were also a trifle thicker in the middle tha on their sides.

In the drawing out of the fillets it sometimes happens that they separat into two layers, more so in the silver than in the gold fillets, which is du to the imperfect mixture of the alloy in melting previous to being cas into ingots.

The inner surface of the fillet will be coated with a thin film of coppe often quite pure, but more frequently in form of a suboxide. From this appears that a globule of copper is enveloped in a volume of the fluid silve or gold, and during the pouring of the metal into the ingot it is drawn ou into a wire. During the subsequent rolling a slip is caused, as otherwis there will be no adhesion between the surfaces of the flattened metals.

FINAL REDUCTION OF THE FILLETS IN THE GAUGING MILL.

The final reduction of the fillets to a uniform thickness is completed i the gauging mill, which differs somewhat in construction from the breal down mill. The upper roll of the gauge mill is held by brasses loosel clamped together, the upper brasses being bolted with set screws in th frame of the mill, the lower brasses being supported by spiral springs, whic also support the upper roll when the mill is not being fed. The lower rol runs on a wedge-shaped brass, resting against another wedge-shaped bras which wedges when closed represent a solid square. Against the wedge brasses, upon which the lower roll runs, a screw is set to adjust these wedge which screw receives its turning from a crown and pinion wheel; th wedge is worked forward and backward by the adjusting of the screw. A the fillet passes between these rolls, the proper thinness being here lik

wise gauged by a scale on a steel instrument attached, the top roll presses against its upper brasses, which impedes any further rising of the roll, and by the adjusting of the bottom wedge by means of the screw the requisite space between the rolls for the passage of the fillets is retained. Upon each adjustment a difference of 0.001 of an inch in thickness can be made upon the fillets. The last rolling of the fillets, however, is completed without any pinch, so as to reduce them to one uniform thinness.

ANNEALING OF THE REDUCED FILLETS.

The very long fillets are now cut into two equal strips by the shearing machine. To prevent the metal becoming brittle they are again annealed in the furnace. The annealed fillets are introduced into a steam chest, which is made of wood, lined with sheet copper, about four and one half feet long, two feet wide, and one and one half feet deep, to which hinged covers are attached. Steam pipes are introduced into the chest, by which the water is raised to the proper temperature, which is about 180 degrees Fahrenheit, into which the annealed strips are introduced, and are kept at this temperature for about ten minutes. The steam is then shut off, and the water allowed to cool; in about one hour the gold fillets are removed and covered with melted wax. The silver fillets, however, are subsequently dipped in tallow.

THE STUBBING OR FLATTENING OF THE FILLETS.

The fillets are taken to the cutting room, where one end of each is trimmed square by a small shearing machine. The next operation is to pass them through the rolls of a stubbing mill. This apparatus consists of small rolls of castiron of three inches in diameter, with a two-and three-fourths-inch face. The lower roll is a plain cylinder; the upper cylinder is beveled, with three faces, whereby its periphery has three rounding and three flat surfaces. When the rolls are set revolving, spaces with openings are made, and as the revolving continues the openings narrow as the rounding face comes down, whereby the ends of the fillets placed therein are "stubbed" or flattened, which flattened part will be reduced to about two thirds its thickness. The distance between the faces of the rolls is adjusted by hand screws on top of the mill.

The end of each fillet is passed into the space of the rolls, which shapes two inches of each strip so as to render that end to the required thinness of admitting it into the orifice of the next machine, called the draw-bench. During the stubbing the fillets rest on a movable guide attached to the mill, and as they are expelled (caused by the revolving of the rolls in opposite direction) they pass into a trough, from which they are conveyed to the draw-bench for final adjustment.

COMPLETION OF THE FILLETS IN THE DRAW-BENCH.

The draw-bench in construction is similar to that used in wire works, designed, however, for flat drawing. It consists of two adjustable castiron rolls, set vertically and revolving in opposite directions, through which the stubbed end of each fillet is passed. The flattened part of the fillet is of the requisite thinness to admit of its passing easily between the cylinders until seized by the teeth of the dog; as soon as that part which was not previously flattened comes against the rolls, the drawing of the fillet commences, requiring much force to drag it between the cylinders to the dis-

charge side, and to reduce it to that exact uniform thinness necessary for "planchettes." As the fillets pass through the draw-bench they are cut into two lengths by the shears attached to the bench. The rolling of the strips is completed by the draw-bench, which began by the large rolls upon the ingots in the rolling room.

THE CUTTING OUT OF THE FILLETS INTO PLANCHETTES OR BLANKS.

The cutting-out presses are run by excentrics on a counter-shaft, to which a series of cams are attached, thereby raising and lowering the shaft of the press; and as it raises the fillet is placed on the bolster, the cutter descends, cutting a "blank," which falls through the bolster into a drawer beneath; as the cutting-out punch rises again, the fillet from which the blank has been detached comes against a guard, which detaches the fillet. A gauge is connected with the press to test any irregularity of diameter and thickness of the blank that may have taken place, which could not be detected by the weight alone.

The fillets, one by one, are passed to the cutter, who cuts two blanks out, one from the first end and one from the middle, thus continuing with the set. Each trial blank is then weighed, on a delicate balance, to ascertain their correctness, and each strip thus proven is cut out into blanks. Should any of the trial blanks prove too heavy, the fillets from which such have been cut are either passed once more through the draw-bench, or, if necessary, with a spring pinch through the gauge mill; if too light, they are adjusted by the cutting-out punches, in altering the diameters of the punch to a very slight extent, or they are cut by a concave punch, so that the lighter blank cut out is thereby rendered by weight to the standard blank. The fillets which are properly cut are carried to the cutting-out press, where they are cut into blanks and scissels.

The blanks are frequently examined to see that the edges retain their smoothness, as the cutter or bolster may fracture the edges, by which a oss of weight is entailed, thereby rendering them unfit for use, and for this reason also the trier, at frequent intervals, sets the weights of a given quantity of blanks, which process is termed "pounding." The blanks are also rung to detect any which may be dumb or cracked. The detached fillets are now the so called "chippings" or "scissels," which have the appearance of long ribbons perforated with round holes. There will be about 60 per cent of planchettes produced from the original weight of the ingots.

CLEANSING OF THE PLANCHETTES OR BLANKS.

The planchettes, as well as any condemned planchettes, and the clippings, are conveyed to the cleaning room, where they are boiled in a solution of potash to remove the wax and restore them to their brightness, and then transferred to the adjusting room. The condemned blanks, chips, and clippings are returned to the melting department through the transfer clerk, in the same manner that the ingots were received.

THE ADJUSTING OF THE PLANCHETTES.

The adjuster tests each planchette on a pair of test balances, and if they prove of standard weight, including the working allowance, are passed, but checked by re-weighing.

If the gold planchettes are too light, they are condemned; if too heavy, they are reduced to their prescribed limit by filing the rim by hand, which

is done by drawing the rim lengthwise over a file, whereby the uniform circumference is retained.

The silver planchettes that are too heavy are not adjusted by hand, but filed by lathes in the coiner's weigh room.

The standard planchettes are weighed once more, to insure complete accuracy, and are made up into drafts to be taken to the coiner's room and weighed; the condemned ones are set in drafts and likewise conveyed to the coiner's room, weighed, and transferred with the other clippings to the melter's department.

The legal tolerance in weight of light or heavy planchettes allowed on double eagles and eagles is one half grain, for half eagles one fourth grain, and for silver dollars one and one half grains. The limit of working tolerance is one tenth grain on the standards and three tenths grains on the light planchettes.

THE COMPRESSING OF THE PLANCHETTES.

The drafts of planchettes are transferred to the press room for the compressing of their edges in the "edge compressor." The planchettes are placed in a tray hopper attached to the compressor and supported by a rod. The compressor is driven by a pulley, which, from a reduced pulley, sets a disc with a groove in motion on the main block of the compressor, which reduced pulley sets also another pulley, cut with notches, in motion. As soon as the driving pulley is started the blanks gradually fall into a tube at the lower end of the tray, where they rest against the notched pulley, and as each notch passes the tube it carries with it a planchette, from whence it is carried into a slide, thence conveyed with some force into a narrow groove of the block of the compressor; said block communicating with the same proportionate groove of the revolving disc. The planchette is finally here caught by the revolution of the disc and grooves, from whence, after two revolutions, the edge is compressed and the planchette falls into a tray. The planchettes by this operation are reduced in diameter, but are thicker on the edges, with the center retaining its dimension, which compression of their edges prepares the blanks for the "crenating" or "milling," which crenating is given by the collar of the die press.

One of these edge compressors can be fitted for blanks of any dimensions, if provided with reciprocal blocks and discs, which can be adjusted in a very short time.

WHITENING AND ANNEALING OF THE PLANCHETTES.

The blanks are sent to the "whitening" room, where they are cleansed in copper pans, by washing in hot water with soap and soda and afterwards rinsing in boiling water.

After drying the gold blanks are placed in copper tubes, luted with fireclay and annealed rapidly, until the tubes attain a full red heat, the time consumed for this operation being from fifteen to twenty minutes. They are then withdrawn from the furnace, and placed on the floor to cool; then immersed in wooden vats containing hot water slightly acidulated with nitric acid, the latter removing the slight discoloration on the surface of the blanks, caused by oxidation. The silver blanks are annealed in open copper vessels, then immersed in a lead-lined vat, containing hot water acidulated with sulphuric acid. The blanks are well stirred in the pickle, in which they remain for about five minutes, after which they are rinsed with boiling water, shaken with basswood sawdust, dried on a steam bath

in open pans, being stirred the while with wooden rakes. The blanks are again weighed and taken to the press room for coining.

THE COINING OF THE PLANCHETTES.

The larger presses are used for double eagles and standard dollars; the smaller for eagles, half eagles, and subsidiary silver. The largest press in the San Francisco Mint has a pressure of about one hundred and seventy-five tons, and turns out about eighty coins per minute. It is claimed that one of the presses at the Carson Mint is the most powerful in the world, requiring five horse-power to drive it.

The planchettes are conveyed to a tube connected with the press, and by an automaton hand, when the press is brought into motion, a planchette is laid from the tube onto the lower die of the coining press. As the automaton hand retires, the collar around the lower die rises and encircles the blank, while the upper die held in the block of the driving stem comes down with a square blow on the blank with great force, converting the blank by one stroke into a perfect coin, giving the relief and depressed impression, as well as the crenated edge. The blow forces the metal into every engraved part of the collar and die. When the day's coining is completed, the dies are taken from the presses and placed in the mint's vault.

THE PYXING PROCESS OF THE COIN.

The coin is returned to the weighing room, weighed and examined, where the breakages are picked out and condemned. The coins now undergo the "pyxing" process, technically so called, by which the weight and fineness of the coined money is determined before it is delivered to the public.

It consists in taking from every journal weight of gold or silver coin a pound, which is weighed on an accurate balance, the plus or minus weight being detected by the weigher, and recorded by the clerk. This determines whether the coin comes within the limits allowed by law.

From the pound weight of gold or silver coin, pieces are taken by the cashiers, in the presence of the Superintendent, in number provided by law, who weighs them with his standard weight. Two pieces are next selected, the one to be assayed in order to test the fineness, the other for subsequent examination at the general trial of the "pyx."

This "pyx" of reserved coin is sent to Philadelphia, to be examined and tested for the weight and fineness of the gold and silver by the Assay Commissioners, who are appointed for that purpose.

The condemned coins are broken, reweighed, and melted in the melting department with the clippings as before described. The filings, dust, and other substances that are liable to contain any metal are put aside until the annual settlement.

When the assay trial proves the coin to be of the legal standard, and the weight is within the legal limit, it is accepted, and the Superintendent authorizes the money to be delivered for circulation.

THE METHOD OF MAKING THE DIES.

An original die is engraved upon a piece of soft caststeel of the same size as the money to be coined. The design is cut into the steel, and its depth is proportionate to the relief required upon the coin. After the finishing of the engraving, the matrix or die is hardened. If the die proves

to be perfect it is placed in the multiplying press, which works in every particular like the coining press, but is moved by hand. An impression is taken from the matrix upon a blank die of cast steel, in the same manner as impressing the coin. The blank die is fixed as the lower die of the coining press, and by working the screw of the press by means of the long and heavily loaded arms, the matrix, as in coining, strikes the blank with a blow of great force, whereby the relief impression is brought upon the surface. The hardness, by compression, of the steel is so great that a perfect impression of the engraving cannot be at first obtained, therefore the die is annealed in an iron shell with animal charcoal, which annealing may have to be repeated two or three times, and after being gradually cooled it is again subjected to pressure, and so on until the impression is satisfactory. By obtaining the impression in the manner described it is called a "puncheon die." When the engraver has made all the delicate touches of the original to it, it is also hardened in the manner as before described, and is used to give impression to blank dies by a similar process; here, however, the impression is sunk, whereas in the other it was in relief. Such are the dies employed in stamping the blanks into coin.

The puncheon by which the die is stamped is of hard, and the blank die is of soft steel. The process of hardening is effected in a castiron shell furnace, lined with firebrick. The puncheon is heated for about an hour; then placed in a brass holder composed of two parts, with a screw clamp for securing the puncheon, and provided with a socket, into which a water pipe is screwed. The water is turned upon the puncheon with great force for about three to four minutes, thereby rapidly chilling the steel. The puncheon is then removed and dried.

The softening is effected by placing the dies in a vessel covered with animal charcoal, allowing them, after annealing, to gradually cool in the closed vessel.

The blank dies are formed of cylindrical pieces of nicely turned and polished steel, of which one end is conical shaped, the other end being square. After the press has given the first blow, whereby the first visible impression is effected, the cone disappears. The die is then taken to a turning lathe to shave off the rim of metal formed round the impression, which then permits, after again annealing as previously described, the next blow of the press to deepen the impression without spreading the steel. These blows, annealing, etc., are repeated till a perfect die is obtained. The durability of the dies varies exceedingly, depending on the quality of the steel, as well as the character of the metal to be stamped, which differs in hardness or softness, according to the nature of the alloy contained in it.

It is requisite that the dies and collars employed in stamping the coins should be frequently tempered to retain their hardness. The rolls of the rolling mill, likewise, will require to be taken apart whenever they begin to wear irregularly, and turned with emery upon the lathe. The dies are also frequently dressed by an emery wheel, in order to retain the bottom perfectly smooth and even.

An accurate register is kept of all dies manufactured, as well as an accounting of all matrices, puncheons, and dies destroyed, so that none can be surreptitiously used or carried away.

TABULATED STATEMENT OF UNITED STATES COINAGE.

Denomination.	Authorized by an Act of—	Weight, in Grains.	Fineness.
Half eagle	April 2, 1792	135.	916⅔
Eagle	April 2, 1792	270.	916⅔
Double eagle	March 3, 1849	516.	900.
Standard dollar	April 2, 1792	416.	892.4
Half dollar	April 2, 1792	208.	892.4
Quarter dollar	April 2, 1792	104.	892.4
Dime	April 2, 1792	41.6	892.4

Denomination.	Change in Weight, by an Act of—	Change in Fineness, by an Act of—	Diameter, in Twentieths of an Inch.	Thickness, in Thousandths of an Inch.
Half eagle	June 28, 1834, to 129 grains	Jan'y 18, 1837, to 900.	17.	0.046
Eagle	June 28, 1834, to 258 grains	Jan'y 18, 1837, to 900.	21.	0.060
Double eagle	....	....	27.	0.077
Standard dollar	Jan'y 18, 1837, to 412½ grains	Jan'y 18, 1837, to 900.	30.	0.082
Half dollar	Feb'y 12, 1873, to 192.9 grains	Jan'y 18, 1837, to 900.	24.	0.057
Quarter dollar	Feb'y 12, 1873, to 96.45 grains	Jan'y 18, 1837, to 900.	19.	0.045
Dime	Feb'y 12, 1873, to 38.58 grains	Jan'y 18, 1837, to 900.	14.	0.032

THE AURIFEROUS GRAVELS OF CALIFORNIA.

GEOLOGY OF THEIR OCCURRENCE AND METHODS OF THEIR EXPLOITATION.

By John Hays Hammond, E.M.

Prior to the gold excitement in California and Australia in the years 1848 and 1851, respectively, the estimated quantity of gold in circulation in the world was from \$2,000,000,000 to \$2,500,000,000. Since the commencement of this golden era, it has been computed that the world's gold circulating medium has been increased by the introduction of about \$4,500,000,000.

The great part California has played in the addition to the world's wealth will be recognized when it is said that fully one quarter of this increase has been derived from the gold mines of that State. Of the entire gold production of California, not less than nine tenths has been yielded by the "auriferous gravels."

The total yield of the auriferous gravels of California would be represented by the value of a cube of pure gold having an edge of fourteen feet. Over \$100,000,000 have been invested in the gravel mines of California.

The auriferous gravels may be divided into two classes:

First—The shallow or modern placers.

Second—Deep or ancient placers.

These terms are indicative of the very characteristic difference that exists between the two classes of placers.

THE SHALLOW OR MODERN PLACERS.

The signification of these terms will be apparent from an explanation of the origin and mode of occurrence of the placers. These placers are superficial accumulations of auriferous alluvions along the gulches, bars, flats, etc., and are designated gulch, bar, or flat diggings, according to their topographical position. The deposits along the modern rivers belong to the shallow placers.

The gold-bearing detritus of which they consist has been derived from the ancient placers or the quartz veins; in some instances, from both sources. Through the disintegrating and transporting power of the meteoric agencies, especially of running water, the material has been brought from the above sources, and redeposited in places of lower elevation, where it was discovered by the pioneer miners. Thus the assorting process has been carried, by natural agencies, one step farther than in the case of the deep or ancient placers, and two steps farther than in the formation of the gold-

The relative costs of working the various classes of gold deposits by methods applicable to the respective classes are:

1. Auriferous vein .... \$3 to \$10 per ton material treated.
2. Drift mining .... 75 cents to \$4 per ton material treated.
3. Miner's pan .... \$5 to \$8 per ton material treated.
4. Rocker .... \$2 to \$3 per ton material treated.
5. Sluices .... 75 cents to \$1 per ton material treated.
6. Hydraulic method .... 1½ cents to 8 cents per ton material treated.

bearing quartz veins. To this process of the higher concentration of the gold is due the extraordinary richness of the shallow placers.

From the shallow placers, and from the beds of the modern rivers, came nearly all the gold produced by California up to the year 1854, and indeed the larger percentage up to the year 1860. The exhaustion of the gold gravels, capable of being worked with profit by such primitive means as were available at that time, led to the abandonment of the shallow diggings.

The unworked deposits, also, often occur below the drainage level.

The pan and cradle, especially the former, are still used for the purpose of "prospecting" or testing the gravel, and for cleaning up the sluices, batteries, etc., at all mines. The accompanying illustrations of these articles suffice to describe them.

The batea is better than the pan for purposes of prospecting gravel or quartz. It is used extensively in South America, Central America, and Southern Mexico. It consists of a shallow wooden bowl, from twelve to twenty-four inches in diameter and of two to four inches in depth from the center depression to the level of the rim. It should be colored black (by paraffine paint) to show the collected gold more readily. The pan is, however, preferable to the batea for cleaning up the sluices, etc.

The flat character of many of these deposits preventing the attainment of the grade requisite for "sluicing" and of the "dump" for the disposition of the tailings, enhances the difficulty of working alluvions of this class. To overcome these difficulties mechanical contrivances of various designs (hydraulic elevators, etc.) have been introduced in some places with considerable success.

River mining by sluices, rockers, etc., is now almost entirely limited to the operations of the Chinese, several thousand of whom, scattered over the State, follow the business in a desultory way. A few of the bars of the present rivers are still being worked by "wing dams," by which at periods of low water the river is diverted to one side so as to leave dry the gravel deposit. "Chinese" pumps are used in this class of mining to drain the deep holes from which the water has not receded after the deflection of the river.

In several localities, Butte and Placer Counties principally, plans are being carried out to work the beds of rivers reputed to be rich by constructing head dams, by which the water is diverted into large flumes, which carry it below the point to which it is designed to extract the gravel. This system involves considerable expense, and is usually attended with great uncertainty as to the success of the enterprise.

Dredges are used in a few localities where gravel occurs below the drainage level of the locality to elevate the gravel to a horizon sufficiently high to obtain the requisite grade for sluicing and for the dump.

Under similar topographical conditions "hydraulic elevators" are used. The modus operandi is as follows: The material piped from the bank is carried by the water into an excavation into the bedrock, at which point is placed the lower end, made flaring, of the pipe through which the gravel is to be raised to the sluices, which are set on the level of the upper end of the pipe. A stream of water, under high pressure, is played through a nozzle into the lower end of the pipe just described, and the gravel washed by the swiftly ascending current upwards through the pipe to the point of efflux into the sluices.

This method materially aids the disintegration of the gravel, wherefore a shorter string of sluices than ordinarily used will suffice. Artotype No. 4 shows the elevator used at the North Bloomfield Mine. The capacity of this elevator is, according to Superintendent Radford, two thousand four

MODE OF USING PAN AND CRADLE.


BRITTON & REY, S.F.

hundred cubic yards per twenty-four hours. The gravel is elevated eighty-seven feet vertically. One thousand three hundred miner's inches of water are required under a pressure of five hundred and thirty feet. In addition to elevating the gravel, the eight hundred inches of water used in piping the two thousand four hundred cubic yards of gravel is also raised with the gravel.*

The gold-saving apparatus of the shallow placer mine—the pan, cradle, tom, sluice, etc.—are now objects of hardly more than historical interest. From their nature, as compared with the illimitable resources of the deep placers, the shallow diggings, as a source of gold, will be but of a transient character. The virtual exhaustion of the superficial gravel deposits gave origin to that "prospecting" for the source of gold which resulted in the discovery of the deep placers and of the quartz veins.

From these discoveries dates the inauguration of mining as a scientific and permanent industry in this State.

EFFECTS OF EROSION.

The erosive power of flowing water is strikingly manifest in the stupendous denudation that has been effected through its agency on the western slope of the Sierra Nevada Mountains. In a very recent geologic time the entire relief of its western slope has been changed. Mountain ridges that were hundreds, and indeed thousands of feet in height, have been utterly obliterated by erosive agencies, while the present elevated position of the deep gravel channels shows how energetic has been the operation of these elements.

The prevalent topographical features of the gravel epoch have been in many instances inverted, and that which constituted the prominences of that age has been, by the resistless erosive power of water, converted into the depressions of to-day.

The detrital accumulations of the gravel epoch thus stand out in bold relief in the topographical features of the western slope of the Sierras, and are everywhere conspicuous objects in the panorama.

As early as 1851, Mr. T. P. Tyson, writing upon the geology and industrial resources of California, noted the existence and described the character of the gravel formation he had seen on his trip (in 1848) through the central mining counties.

THEORIES OF GENESIS OF "ANCIENT RIVERS."

Other travelers followed Mr. Tyson, each with his "theory" as to the genesis of the auriferous gravel formation, and it may be of interest to review a few of the more widely entertained of these theories, especially as some of them have not yet been wholly eradicated from the popular mind.

The "marine theory," which referred to the formation of the gravel deposits to the action of the sea, was, for many years, the most popular of the hypotheses evolved to explain the phenomena connected with the auriferous gravels.

The palæontological evidence on this point is most unequivocal. The absence of massive fossils on the one hand and the presence of remains of

* Since writing the above I learn from Mr. L. L. Robinson, the President of the North Bloomfield Company, that the hydraulic elevator has been abandoned because of the great expense attending its operation. He thinks, however, that for heights up to about forty feet the elevator would work to advantage under favorable conditions, as to cost of water, etc. The company is making other experiments in this direction at present.

terrestrial life on the other hand, are not only a most conclusive refutation of the "marine theory," but a positive proof that these deposits were of a subaerial origin. Other considerations (the distribution of the deposits, the character of the component parts of the formation, the remains of what were unmistakable portions of the banks of ancient rivers—the rim-rock, etc.) impel one to the above expressed conclusion.

The "glacial" theory was one which, for awhile, had many advocates. It finally lost its prestige when geologists conversant with glacial phenomena began to investigate this subject. The absence of the "bowlder clay" of the glacial striations, and of the rounded hummocks (called "roches mountinnées") is negative evidence regarding the glacial theory. Per contra, the character of the bedding, the sub-angular and rounded bowlders, show that water, not ice, has been the transporting agent in the accumulations of the auriferous gravels.

At the time Whitney began his examinations the "fluviatile, or deep river theory" had already many adherents. But, with this theory, was unfortunately connected the blue lead theory; or more accurately speaking, the "fluviatile" theory was embodied in the latter, which received the support of many geologists.

This (blue lead) theory supposed the existence of an ancient river flowing from the northeast to the southwest, and having its general course parallel to the crest of the Sierra Nevada Mountains.

The theory derived its name from the bluish color of the gravel filling the channel; and the adherents of this theory profess to be able to identify and to coördinate with the blue lead, by means of this characteristic color, isolated bodies of gravel in various portions of the State. The detailed examination of the geographical positions of the old river channels and their outliers has shown that no river or system of rivers followed this course in the gravel epoch, and the very foundation of the theory was thus destroyed. Furthermore, to this theory, as Mr. Goodyear says, exists the insuperable objection that its acceptance involves the assumption of an uplift or elevation of the Sierra Nevada Mountains, subsequent to the gravel epoch, to account for the change in the present system of drainage with reference to the system of drainage existing during the gravel period. That no such oscillation of level has occurred since the deposition of the deep gravel is, in the writer's judgment, susceptible of proof by the study of the structural geology of the Sierras.

Furthermore, that there is no necessary connection between the bluish color of the gravels and the source from which the material has been derived, will be demonstrated in connection with the discussion of the materials filling the channels.

The blue lead theory, like the glacial and marine theories before it, has now been generally discarded by the investigators of the auriferous gravels, and there has been generally accepted the "fluviatile" theory in its essence, ascribing the origin of the gravel accumulations to the depositions of ancient rivers with courses similar to the present rivers. The character of the deposits show that there has been an intermittent action. The torrential period and the quiescent period are both shown in alternating heavy and light material of the channels. But while there is this unanimity of opinion as to the origin of the gravel accumulations, there still exists a difference of opinion regarding the geological age of the deposits.

GEOLOGICAL AGE OF THE ALLUVIONS.

Authorities differ as to the age of these deposits. Whitney refers them to the tertiary (pliocene) period, while Le Conte assigns them to the qua-

HYDRAULIC ELEVATOR BLOOMFIELD MINE.

ternary age. The palæontological evidence probably favors Whitney's classification. It is certain that the predominant flora and fauna are tertiary, but it is not impossible, Le Conte insists, that this pliocene life has lingered into quaternary time.

The mastodon is distinctly pleistocene, and remains of mastodons have been found in the deep river gravels.

MATERIAL FILLING THE CHANNELS.

Lava.—This may be a true lava, brought into its present position by a lava flow, or, as more generally is the case, the term refers to lava of a fragmental and tufaceous character. Lava bowlders are more or less rounded, water-worn bowlders of volcanic origin, brought into their present position by running water. Volcanic breccia and volcanic conglomerates are likewise designated by the term "lava." The most common form of lava is the material of the "light-colored, fine-grained, homogeneous beds, resulting from the consolidation of the ashes and volcanic mud."

The lava of the tufaceous variety is sometimes very compact, and has a metallic ring when struck, resembling "clink-stone" (phonolite) in this respect. In this lava crystals of glassy feldspar often occur.

The lava is nearly always found "capping" (overlying) the gravel, but in some localities it occurs interstratified with the gravel.

Beautiful dentritic markings (called "photograph rocks") are often found covering the lava. These markings are usually mistaken for impressions of plants, but they are of inorganic origin, having been formed by percolating waters, carrying oxide of manganese and oxide of iron, which substances have assumed the dendritic or tree-like form.

Cement is a term of variable signification. In some districts it designates volcanic material of brecciated or conglomerated character. In other localities it refers to a quartz (non-volcanic rock) conglomerate cemented by oxide of iron.

Pipe-clay is more or less indurated clay, of non-volcanic origin, forming finely laminated beds. It generally occurs interstratified with beds of sand, etc.

Plants, infusorial earth, etc., imbedded in the clay and lava deposits, are often found; fragmental specimens of leaves of various kinds, carbonized wood, and a sort of lignite is found abundantly in the channels. There is an abundance in many localities of petrified wood, formed by the silicifying actions of percolating siliceous waters. The fossil flora of the gravel beds is different from that of the present time, and is referred to the miocene or to the pliocene epoch of the tertiary age.

Often intercalated in the deposits of white lava, are found beds of infusorial earth. This substance is the remains of the silicious shells of microscopic plants (diatoms).

This earth has a magnesian or chalky aspect, is very light, and does not effervesce or dissolve with acids. Diatomaceous deposits are common in the European tertiary.*

Gravel.—The term refers to the water-worn pebbles or bowlders which occur generally as a more or less compact conglomerate, immediately overlying the bedrock. There is considerable heterogeneity in the lithological character of the conglomerate, though pebbles or bowlders of a quartzose character often predominate. Usually subordinate to the quartzose pebbles or bowlders are others, which are sometimes foreign to the lithology of the district, and have been transported long distances.

* The lava, volcanic sediment, and pipe-clay but very rarely carry any gold, and the presence of the gold in these formations is entirely fortuitous.

In some channels, the gravel consists entirely of quartz, while in ot quartz is altogether absent.

The cementing or binding material is sometimes calcareous, but ge ally ferruginous and siliceous. The infiltrating waters carrying the ceous and other cementing material have most probably come from ab and not, as Whitney suggests, from below. In most instances lava been the material from which the transmitting agencies have been deri

Color of Gravel.—The term "red gravel" is given to the brownis reddish colored conglomerate which forms the top and overlies the gravel, which is the bluish, grayish, or greenish colored gravel neare the bedrock.

The gravels owe their color to the difference in degree of oxidation hydration of the iron constituents which form the cementing or binc matter of the conglomerate. The "blue gravel" has very often iron in form of finely divided iron pyrites, and to the presence of this mineral, of some of the ferrous salts, most probably is due the peculiar color. oxidation of the ferrous salts and the pyrites converts the iron into ar drous sesquioxide, which imparts the red color to the red gravel. addition of water changes the anhydrous to the hydrous sesquioxide, the gravel assumes a hue more or less brown, depending upon the de of hydration, and is seen as a variety of red gravel.

As has been shown, the color of the gravel is entirely independent of source from which it has been derived.

Color of Gravel as Indication of Value.—That the blue gravel is gravel cannot be true other than in a relative sense. It is true that blue gravel is almost always richer than the red gravel, but, *per se*, the c of the gravel is no criterion of its absolute value. The gravel is ri nearer the bedrock than in the upper portions of the deposits, becaus its great specific gravity, etc., and the color of the gravel in the lower tions is blue, because the lower horizons are less exposed to the oxidi influence than the upper horizons of the deposit, where the atmosph agencies have had access and have changed the original blue color of deposit to the red color now characteristic of top gravel. The gold oc disseminated throughout the greater portions of the red and blue gra It is not uniformly distributed, but is finer as regards its texture, and abundant in the top gravel than below in the blue gravel. The pay gr is generally confined to the blue gravel, and in some mines, especi where the more expensive process of drifting is adopted, the "pay grav rarely extends more than three to five feet above the bedrock. Whe schistose rock forms the bedrock, the gold is often found included betw the laminæ, several feet below the bedrock.

The quartz bowlders found in gravel mines often carry considerable g At Polar Star Mine, Dutch Flat, a white quartz bowlder was found wh contained $5,760 worth of gold. The gold has undoubtedly been deri from the gold-bearing quartz veins so numerous along the western slop the Sierras. By water it has been transported and deposited along w the detritus in preëxisting valleys, where now found. In the quartz ve the gold rarely exists of such large size as often found in the gravel depo and this would seem to be incompatible with the theory of its source as ab given.

Formation of Nuggets.—To explain this seeming incongruity sev theories have been advanced. Professor Whitney is of the opinion that gold veins were richer nearer the surface in pliocene times than now, maintains that gold veins get poorer as depth is attained. In the ju ment of the writer, who has examined nearly all the mines of this St

connection between the richness of the ore and the depth at ıd. A more plausible explanation of the formation of the nuggets been suggested by Le Conte and other geologists, that their large n due to a chemical as well as a mechanical phenomenon. It bable that the gold has been re-dissolved and re-precipitated. ion, the iron pyrites has been changed into the sulphate. Per-)lutions of the sulphate of iron dissolve the gold with which it :ontact, and coming in contact later with organic or other reduc- ies, the sulphate of iron is changed by them to the sulphuret, the gold as this change takes place. By the deposition of gold ıch manner, from solutions constantly in the same place, nuggets l.

WIDTH OF CHANNELS.

.th of channel worked in hydraulicking varies from one hun- fifty to one thousand feet. The width of the deep rivers on top n a few hundred feet to several thousand. At Columbia Hill, , and other places, the rivers are from one mile to a mile and a

places, where the gravel deposits have a great extent, laterally may be due to the confluence of two or more streams or tribu-

xpanses of alluvions may also indicate the embouchures of the vers at these points.

figuration of the western slope of the Sierra Nevada Mountains, · times, differs from that of to-day in one important respect: in nes the slope was more uniform and more gently undulating at s, through which flowed the pliocene rivers, which were broader ›wer than those of to-day.

›nsequence of this, we find broad pliocene rivers as contrasted nore narrow and torrential streams of our times. As Whitney ıe gravel rivers, when choked with debris, had room to make :lves new channels to one side or the other. They refused to be within fixed limits, and thus wear down one narrow channel, ıe volume of water was too great."

ıifting of courses has given the ancient rivers their present ne aspect, and has complicated the study of their systems. ı are generally broadest at their bends, owing to the shifting of ses, as the banks on the concave side wear away.

formity that is generally considered as a characteristic feature tribution of the gold in gravel channels rarely exists. On the l there is almost always a great fluctuation in the value of gravel ›ss the stream and likewise along the course of the stream. The .nnels are usually less "spotted" as regards the value of the gravel ımaller channels.

mining this tendency is well marked in the occurrence of the s," to which the extraction of gravel is restricted. These leads .y near the lowest depression of the channel, but often make to other side and have most sinuous courses and varying widths. ı of these pay leads is determined primarily by the cost of min- əre low grade gravel can be profitably worked, the width of the obviously would be greater than where a more costly system

ds one hundred to one hundred and fifty feet are regarded as of average width. Where rich gravel, $5 to $8, is the minimum ked, such leads are often only from fifty to seventy-five feet wide.

Where gravel of $2 to $4 is being mined, the width of the pay lead may often reach three hundred to four hundred feet.

GRADE OF THE RIVERS.

As with the rivers of the present day, the grade of the pliocene rivers is very irregular, varying from five feet to two hundred and fifty feet or more per mile. (In some of the smaller tributary channels, the grade is four hundred feet and upwards per mile.) In common with the rivers of to-day, they have falls, rapids, etc., and exhibit all other characteristic fluviatile phenomena. The direction of flow of the pliocene rivers is indicated by differences in level between points on the bedrock, and also, where settling has not occurred, by the bedding of the deposit. The smaller ends of rocks, it is generally believed, point down stream.

As compared with their modern representatives, the pliocene rivers had less grade in their upper portions and more in their lower courses. The gradients of the pliocene rivers were also more uniform, but even in some of the larger channels the grade increases or decreases rapidly within a short distance. In the Bloomfield Channel, within a thousand feet, the grade decreased from one hundred and fifty feet (its average grade) to fifty feet per mile.

DEPTH OF GRAVEL.

The depth of the gravel deposit (*i. e.*, the height of the bank as it now exists) is exceedingly variable, not only as between the different mines, but in the same mine, owing to the erosion of the surface, which has given rise to superficial inequalities.

In some places, as at Table Mountain, Tuolumne County (see section of this deposit), the gravel is not more than two feet in thickness. In other places the gravel deposit attains, it is stated, a depth of six hundred feet, as at Columbia Hill, Nevada County.

DISTRIBUTION OF GOLD.

The paragenesis of the gold in the auriferous gravels of California differs from that in similar formations elsewhere, in the comparative paucity of the associated minerals.

Zircon, magnetic pyrites (chiefly in the form of sand), and garnets are the most abundant minerals accompanying the gold; but platinum, iridosmine, rutile, epidote, diamonds, chronite, topaz, cassiterite, and other minerals, also occur. The gold appears in size from minute particles (finest flour) to large nuggets* weighing several pounds. Gold from size of flax seed to melon seed is, as a general thing, considered coarse gold. Gold from top gravel is textually fine, and also of high grade, the coarser gold being nearer the bedrock. The gold usually is of a flattened character, well rounded on its edges. Occasionally the gold is rough and but little water-worn, and frequently still in its matrix. Gold found in upper gravel often has preserved its crystalline form. Rusty gold is often found in the alluvions. The rusty character of the gold is probably due to a coating of silica and sesquioxide of iron. It is not readily, indeed at times not at all amalgamable. Such gold, when saved, is recovered entirely by rea-

* The largest mass of gold found in California, within the knowledge of the writer, was extracted from the vein in the Morgan Mine, Calaveras County. It weighed one hundred and ninety-five pounds, and was worth $43,534. One or two nuggets worth from $25,000 to $30,000 each are said to have been found in gravel deposits of this State. There are many well authenticated finds of nuggets ranging from $5,000 to $10,000 in value. Large nuggets rarely occur in the large hydraulic mines.

n of its specific gravity. The richest gravel, as a rule, occurs on and ear the bedrock. Sometimes, however, equally rich gravel is found in he upper horizons of the channels, notably on benches occurring on the nner side of a bend in the course of a channel. At Cherokee, Butte County, immediately overlying the bedrock, is a coarse, strongly cemented conglomerate, of a bluish color, carrying but little quartz. The depth of this conglomerate will vary from ten to fifty feet. On top of this conglomerate is a layer of soft blue gravel, varying from one to ten feet in thickness. This layer carries gold quite freely. Overlying this soft blue gravel lies a stratum *sui generis*, called "rotten bowlders," which consist of decomposed quartz, carrying gold varying from $2 to $5 a cubic yard. Above this stratum lies a stratum of quicksand of unknown thickness. At the present time, on top of this stratum of quicksand lies a stratum of hard, tenaceous pipe-clay over three hundred feet in thickness. On top of this pipe-clay is a deposit of basalt one hundred to five hundred feet in thickness. Owing to the large quantity of barren superincumbent material, hydraulic mining has been abandoned. The company purpose to introduce drift mining. The old washings of surface ground near Malakoff, Nevada County, from 1870 to 1874, is estimated at about three million two hundred and fifty thousand cubic yards, the yield of which was about $2\frac{2}{10}$ cents per cubic yard. The Bloomfield Company, from November 29, 1876, to October 13, 1877, washed one million five hundred and ninety-one thousand seven hundred and thirty cubic yards of top gravel, which yielded $3\frac{8}{10}$ cents per cubic yard. During the same period that company washed seven hundred and two thousand two hundred cubic yards of bottom gravel, which yielded $32\frac{8}{10}$ cents per cubic yard. The bottom gravel extended from bedrock to a height of sixty-five feet. All the gravel above that horizon was considered as top gravel.

The depth of the top gravel varied from a few feet to over two hundred feet.

The steep bedrock is more favorable for rich gravel than where the bedrock is flat, but often the gravel is poor where the channel is narrow and steep.

Gravel that yields remunerative results by the drift process has been worked in some instances from sixty to one hundred and fifty feet above bedrock. The coarser gravel ("heaviest wash") is the richest. The light "wash" and material of a sandy character, is usually poor in gold. The top gravel of hydraulic mines rarely pays for piping, unless worked in conjunction with the underlying richer auriferous deposits. The gold is often found in the grass roots of the vegetation covering the gravel deposits, but not in considerable quantities. The top gravel of a deposit is usually richer than that lying a foot or two below the surface, owing to the concentration of the gold superficially. In schistose rocks, as well as in decomposed granitic rocks, the gold is often found in the bedrock at a depth of from one to five feet below the surface. In drift mining, the bedrock is stripped to recover this gold. In hydraulic mining, bedrock of this character, when not too hard, is piped. When necessary, bedrock is blasted before being piped.

BEDROCK.

Bedrock is the rock which formed the bed over which the ancient river flowed. Slate is the common bedrock, though granite forms the bedrock in some localities. In different parts of its course the bedrock of a channel may change in character. The slate varies greatly in its lithological character. Chloritic, talcose, serpentine, and siliceous slates predominate. Schistose rocks are regarded as more favorable bedrock than granitic.

Where the stream runs with the stratification of the bedrock, the gravel usually richer than where it cuts across the stratification. In some depo its strata of indurated clay, or of compactly cemented gravel, form wha is called a false bedrock. This bedrock often occupies an horizon consic erably above the true bedrock. Sometimes the conditions of drainag necessitate the adoption of this stratum as the working bedrock of th mine, and operations are conducted with reference to this false bedrock, ii lieu of the true bedrock.

YIELD OF CHANNELS.

The aggregate length of the ancient channels has been estimated at four hundred miles. This does not include the so called cement channels, which are but of subordinate economic importance. The yield, per mile, of channels of the average character is, at a low estimate, from $2,000,000 to $3,000,000. Good channels for drifting yield from $100 to $500 per lineal foot of the stratum extracted. From one fifth to one half of the gold in the channels usually may be obtained from drifting where the bedrock gravel is accessible; the lowest stratum of gravel, four to eight feet in depth, carries this portion of the aggregate gold contents in the channel.

SECTIONS OF GRAVEL DEPOSITS.

Section across Table Mountain (Tuolumne County), after Whitney.

1. Top. Basalt, overlying andesitic cement, sixty feet (forming a bluff sixty feet high).
2. Bluish soft sandstone, seventy feet.
3. Whitish clays, ten feet.
4. Auriferous gravels, two feet.
5. Bedrock slate.

Section through Shaft 1, Malakoff (North Bloomfield Gravel Mining Company).

Depth of eight to ten feet, soil.
To depth one hundred feet, gravel.
At one hundred feet, streaks of clay mixed with the gravel for a few feet.
At one hundred and twenty feet, a foot or two of sand.
At one hundred and thirty feet, much quartz; pipe-clay disappeared.
At one hundred and forty feet, gravel became more firmly cemented.
At one hundred and seventy-five feet, all the gravel well cemented.
At one hundred and ninety-five feet, thin strata of sand for a few feet.
Then to two hundred and five feet, more cemented conglomerate.

Section at La Grange Mine (Stanislaus County).

1. Top. Red soil colored by Fe_2O_3.
2. Coarse red gravel (containing granite pebbles, etc.).
3. Red cement (hard pan) gravel cemented by Fe_2O_3.
4. White siliceous clay.
5. Red cement (as No. 3).
6. Sand with pebbles.
7. Loose yellow sand.
8. Dark-colored gravel, containing debris of granite, slate, diorite, serpentine, etc., witl some quartz.

It will be observed that quartz forms but a small part of the gravel a La Grange, which is indeed composed almost entirely of granite, diorite etc. This is quite anomalous in the geology of the auriferous gravels.

The above sections will show how great a diversity exists in the relativ depth or thickness of the material filling the channels. In some localitie the gravels are capped (overlaid) by two hundred to one thousand feet « "lava," "pipe-clay," sand, etc. In other places, as at Bloomfield, etc where hydraulic mining was most successfully conducted, the volcani

formation is entirely subordinate, and comparatively little of the non-paying superincumbent material has to be "piped off" before the pay gravel is reached. The "lava" capping in Placer and Nevada County is not the "lava" flow which caps the gravel formations at places in Tuolumne, Butte, and other counties, but it is of a sedimentary origin.

In some channels, where the grade is very steep, there was no deposit of gravel. A subsequent deposition of volcanic sediment covered the bed-rock. This occurrence is to be seen in the Black Cañon Channel.

SKETCH 1.

CROSS SECTION OF SECRET HILL AND CANADA HILL CHANNELS.

This sketch shows the *elevated* position of this ancient river system, with respect to the modern drainage system (North Fork of American River), and the sea level. Some gravel deposits of this class occupy altitudes even higher than the Canada Hill system. This deposit has been drifted at several points, and also hydraulicked where the volcanic capping had been denuded.

E. represents an isolated bench of gravel about one half mile long and eight hundred feet wide. The grade of this channel is very steep, being about six feet per one hundred feet. Channel is about three hundred feet wide at gravel line.

SKETCH 2.

CROSS SECTION OF RIDGE BETWEEN NORTH AND MIDDLE FORKS OF THE AMERICAN RIVER.

This sketch shows where the deep river system is *below* the drainage level of the district. The diversion of the ancient stream into other channels was caused by the volcanic flow. The submerged position of the deep river channels with respect to the present river systems is not usual in the upper portions of their courses. Near Oroville, the Feather River passes over a submerged ancient channel.

SKETCH 3.

LONGITUDINAL SECTION OF DAMASCUS CHANNEL AND CROSS SECTION OF THE RED POINT CHANNEL.

This sketch shows the older (Damascus) channel, which has been cut through by the younger (Red Point) channel. The gravels filling these channels have been derived respectively from different sources. The gravel of the Damascus Channel is white, and is almost entirely composed of quartz pebbles and bowlders, while that of the Red Point Channel is black, and consists of a slate, very siliceous and highly metamorphosed.

SKETCH 4.

CROSS SECTION OF DAMASCUS AND BOB LEWIS CHANNELS.

Dotted lines, M. N. and M'. N'. show the original channel. These rims have been washed away since the "volcanic" deposit was found. F. F. F. are benches of gravel left on the west rim of the ancient channel. There were, probably, corresponding benches on the east rim, which, together

with the rim, have been washed off and obliterated. Subsequent to the deposition of the gravel in the Damascus Channel system (C. and F.F.F.) a new channel (E.) has crossed and scoured out the older channel (C.). The gravel of the Damascus Channel is white, while that of the Bob Lewis Channel is black. The dotted lines M. N. and M'. N'. represent the original Damascus Channel's rims. The east rim of the original channel has been entirely carried away by the younger (Bob Lewis) channel.

SKETCH 5.

CROSS SECTION OF RED POINT CHANNEL AT HOG'S BACK AND BLACK CAÑON.

The Black Cañon Channel has a grade of eight feet to the one hundred in places. The space included within the dotted lines N. M. Y. M'. N'. has been obviously denuded since the deposition of the volcanic cappings. M. represents the vertical depth of the erosion subsequent to the volcanic formation. The vertical depth at this point is from one thousand eight hundred to two thousand feet. The dotted lines N. M. R. and N'. M'. R'. are the rims of the ancient channel. These rims were eroded subsequent to the deposition of the volcanic cappings. The harder capping has resisted erosion, while the softer slate rims have been denuded. Dotted line M. M. represents level of channel at time of lava flow.

SKETCH 6.

CROSS SECTION OF RED POINT AND DAMM CHANNELS.

E. is mixed quartzose (white) gravel on rim. This was left by some ancient channel which was subsequently scoured out by Red Point Channel (black gravel channel). Dotted line N. M. denotes the probable original west rim of the ancient channel, and N'. M'. the probable east rim. There have been, probably, three channels of different ages in this locality. The quartz channel, of which E. is a remnant, has been scoured out and obliterated by the younger black slate channel (Red Point Channel). The east rim, N'. M'., of the valley, through which the ancient Red Point River flowed, has been partly eroded by the youngest river of the three systems; *i. e.*, the Damm Channel.

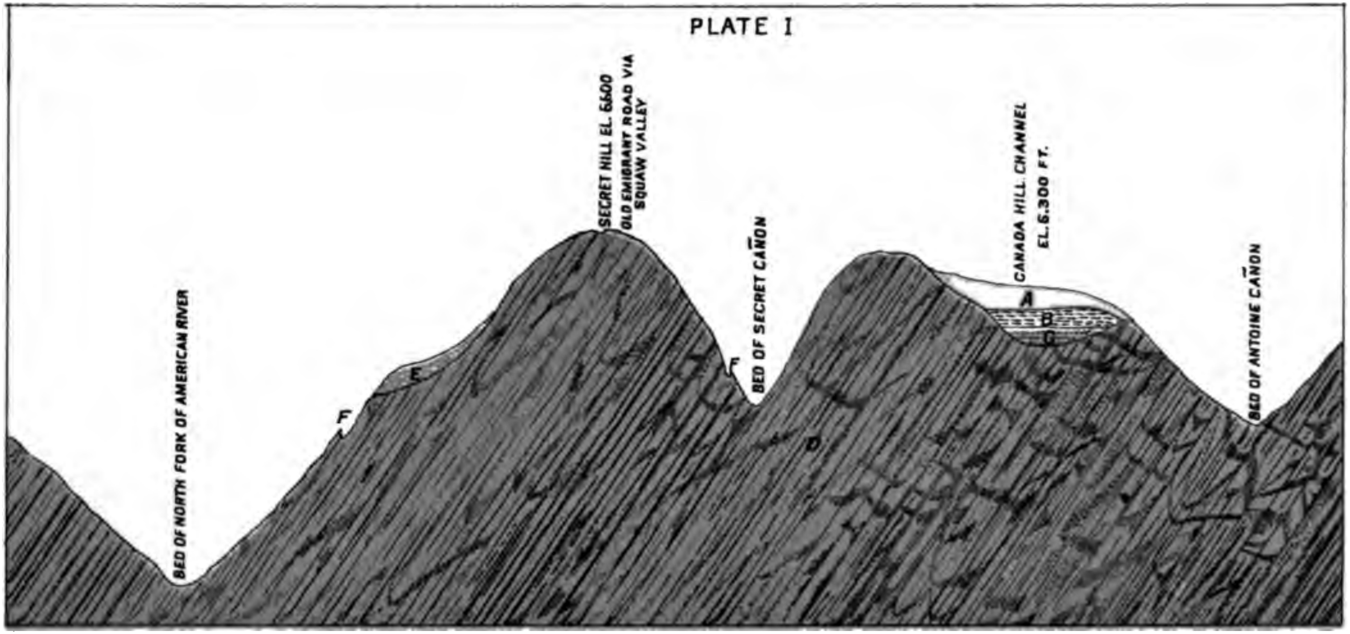
SKETCHES 7 AND 8.

LONGITUDINAL AND CROSS SECTIONS OF IOWA HILL CHANNEL SYSTEM.

The gravel channel, as illustrated in this sketch, has been entirely carried off in places through erosion by the North Fork of the American River, and by the waters of the Indian Cañon. The volcanic capping (volcanic sediment consolidated), which originally covered the channel, has been denuded at Iowa Hill and at Wisconsin Hill. At those points the gravel has been profitably hydraulicked, while the gravel which underlies the Morning Star Hill is not susceptible of being hydraulicked on account of the superincumbent volcanic capping. Where this capping was not more than fifty feet deep hydraulicking paid. The lower stratum of blue cemented gravel has been extensively drifted. The width of this channel shown in plate 8 (cross section) is nearly two miles.

NOTE.—These sketches are not made to scale.

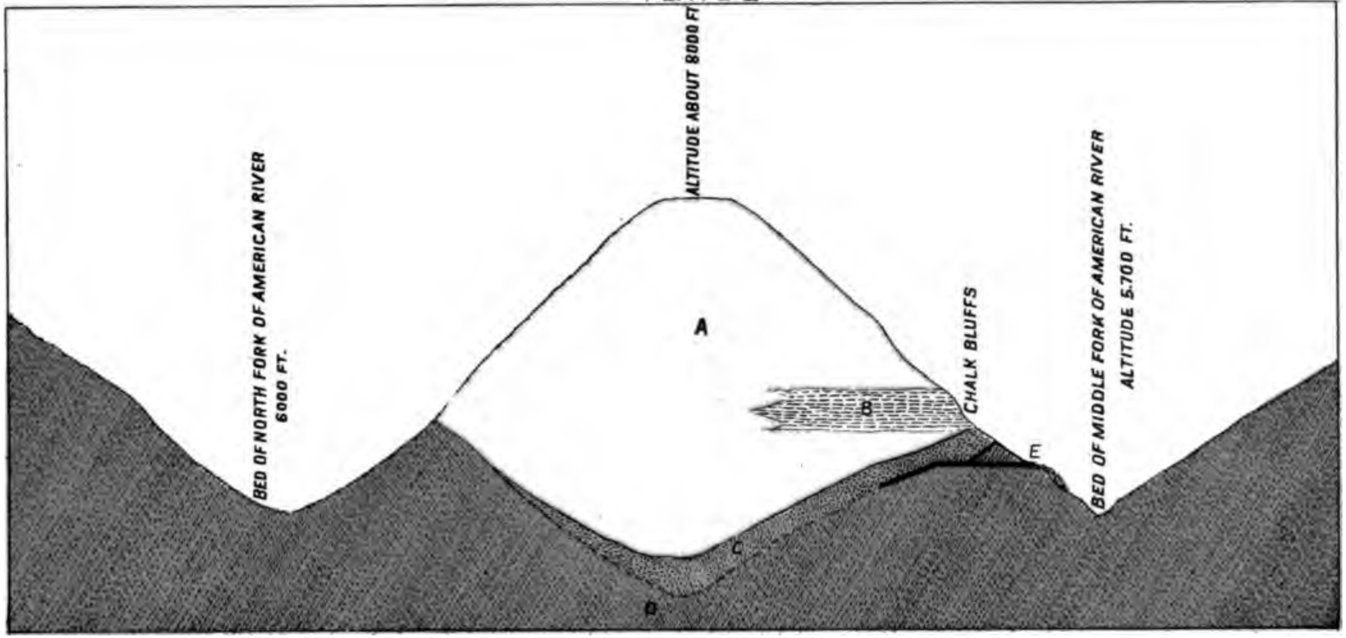
PLATE I



CROSS-SECTION OF SECRET HILL AND CANADA HILL CHANNEL. SKETCH (AFTER HOBSON).

A. Volcanic Cement Capping, 40′ to 150′ deep.
B. Cemented White Siliceous Sediment, 40′ deep.
D. Slate Bed-rock, gashed with numerous veins of quartz.
E. Bench of Gravel.

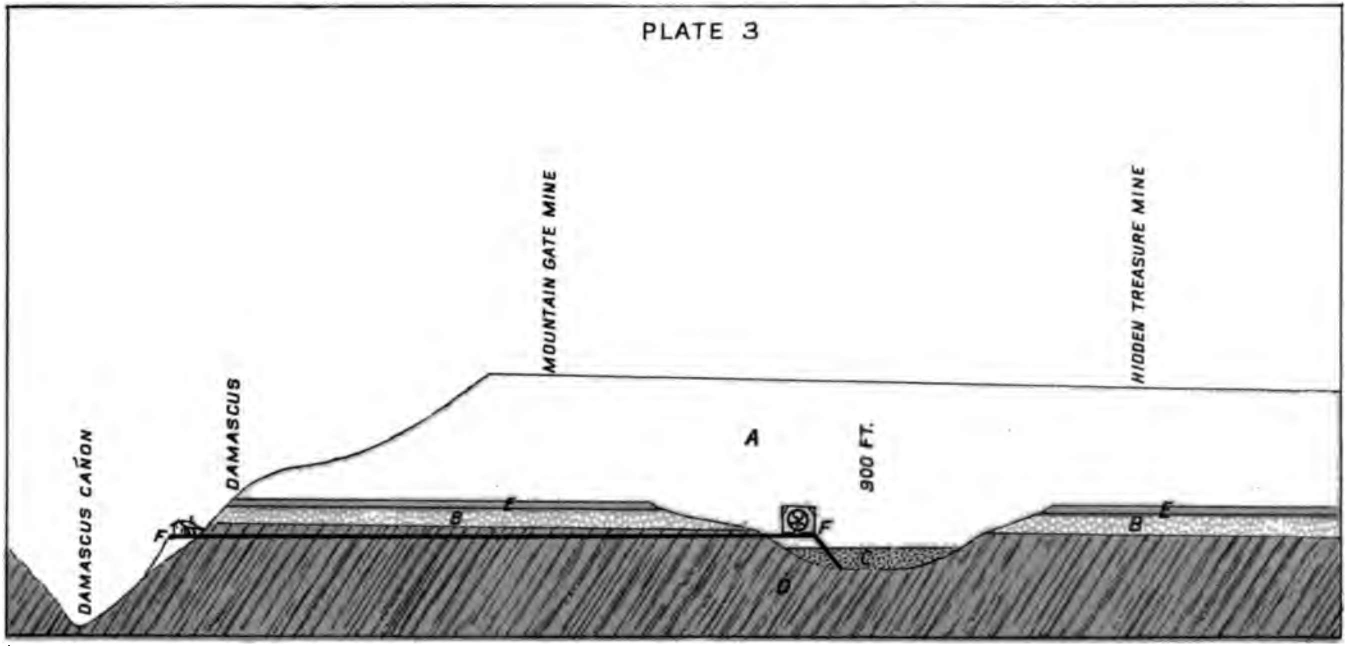
PLATE 2



CROSS-SECTION OF RIDGE BETWEEN NORTH AND MIDDLE FORKS OF AMERICAN RIVER.

A. Volcanic Capping.
B. Cemented White Siliceous Sediment.
C. Gold-bearing Gravel.
D. Granite Bed-rock.
E. Prospect Tunnel and Slope (inclined shaft) sunk on the rim to work the gravel deposit.

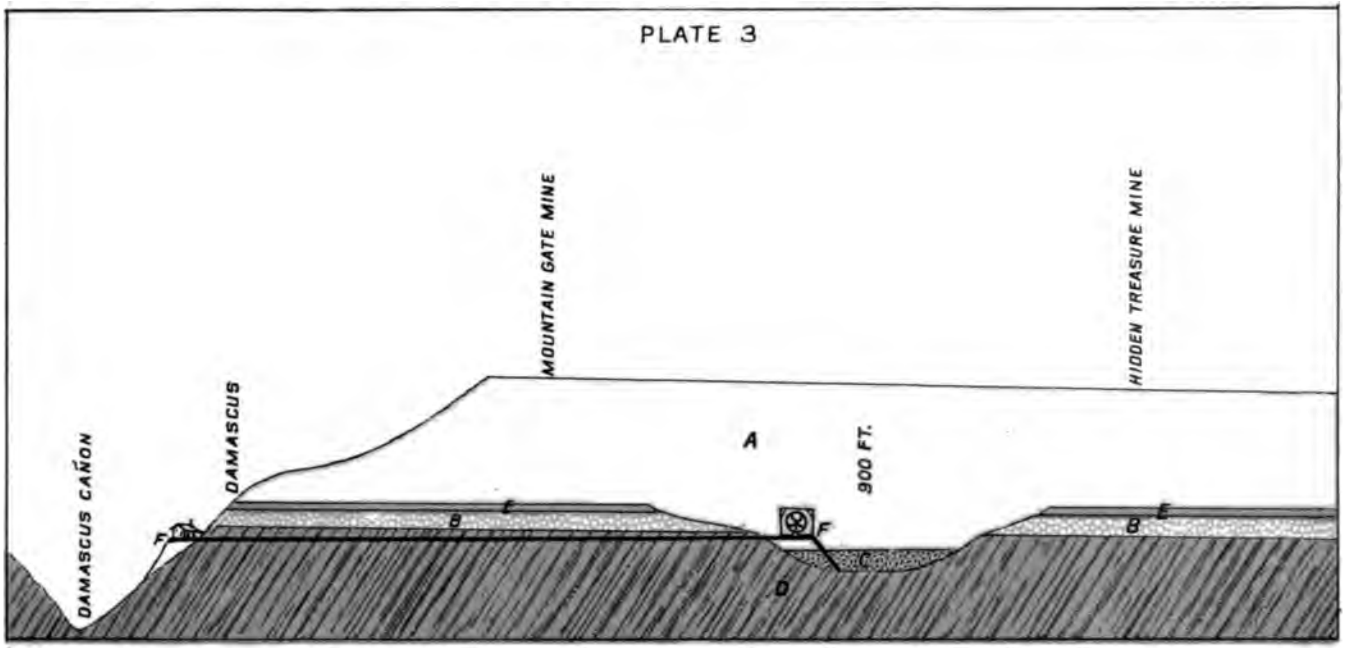
PLATE 3



LONGITUDINAL SECTION OF DAMASCUS CHANNEL, AND CROSS-SECTION OF RED POINT CHANNEL.

A. Volcanic Capping.
B. Damascus Channel (Gravel composed almost entirely of white quartz.)
C. Red Point Channel (Gravel composed almost entirely of black, highly siliceous slate.)
D. Slate Bed-rock.
E. Pipe-Clay.
F. Working Tunnel and Incline.

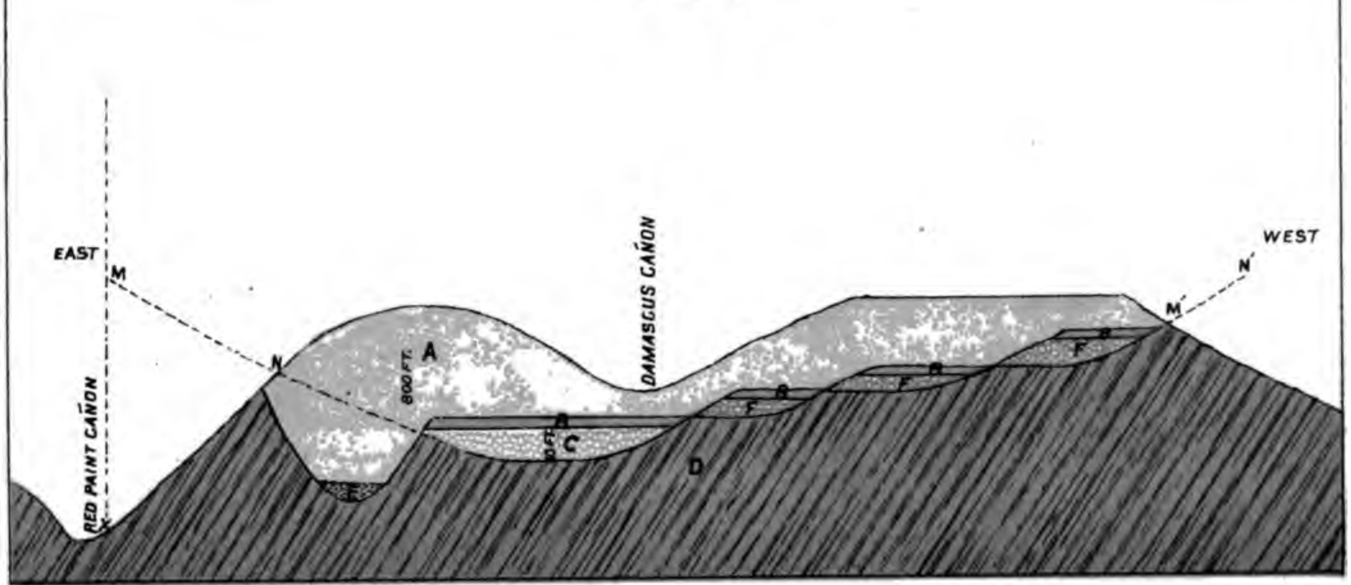
PLATE 3



LONGITUDINAL SECTION OF DAMASCUS CHANNEL, AND CROSS-SECTION OF RED POINT CHANNEL.

A. Volcanic Capping.
B. Damascus Channel (Gravel composed almost entirely of white quartz.)
C. Red Point Channel (Gravel composed almost entirely of black, highly siliceous slate.)
D. Slate Bed-rock.
E. Pipe-Clay.
F. Working Tunnel and Incline.

PLATE 4

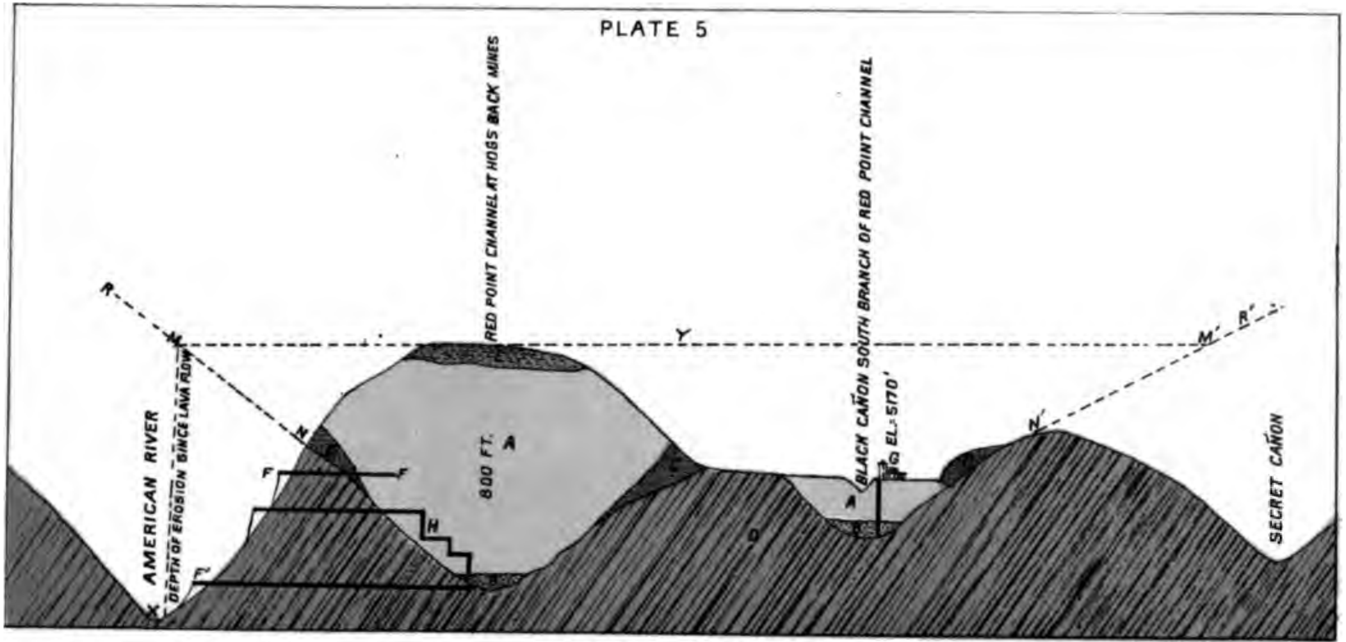


CROSS-SECTION OF DAMASCUS AND BOB LEWIS CHANNELS.

A. Volcanic Capping.
B. Pipe-Clay.
C. Damascus Channel, white quartz gravel.
D. Slate Bed-rock.
E. Bob Lewis Channel, dark gravel.
F. Rim benches of quartz gravel.

E is 150' wide. C is 1000' wide, and has been worked to width of 300'.

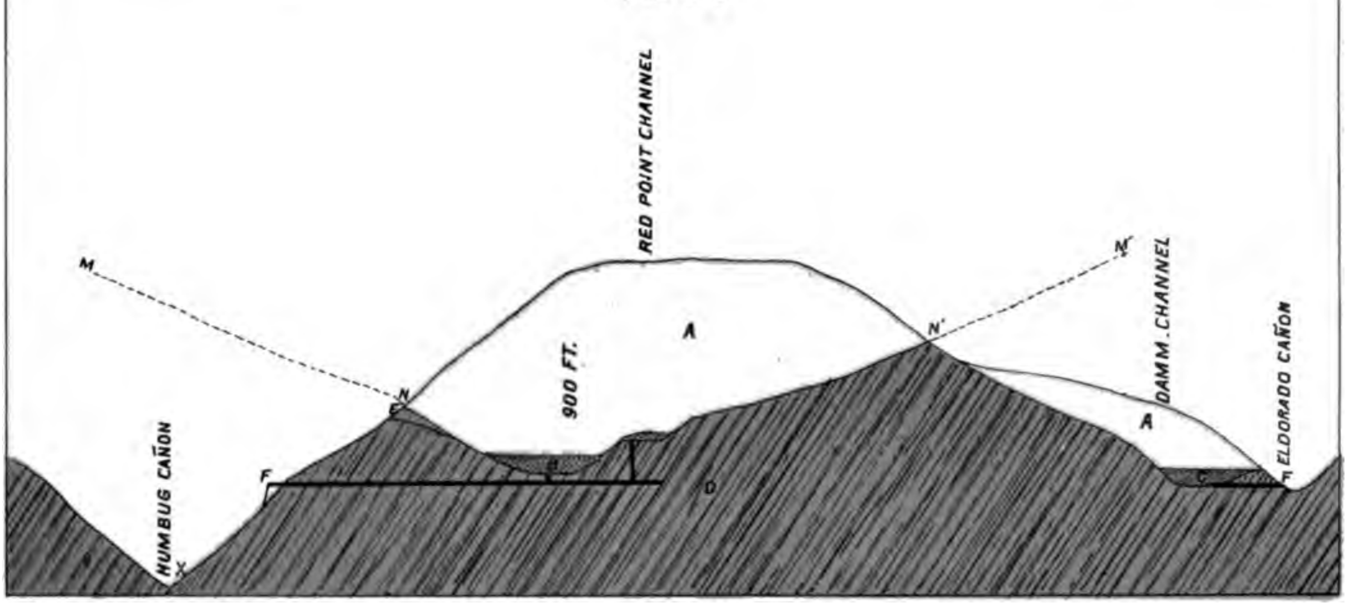
PLATE 5



CROSS-SECTION OF RED POINT, HOGS BACK AND BLACK CANON CHANNELS.

A. Volcanic Capping.
B. Gold-bearing Gravel Channels.
C. Mixed Gravel on Rims.
D. Slate Bed-rock.
E. Deposit of angular Debris and Boulders.
F. Prospect Tunnels.
F'. Tunnel being run to bottom gravel deposit.
G. Black Canon Shaft and Hoisting Works.
H. Prospect Winzes to strike Gravel.

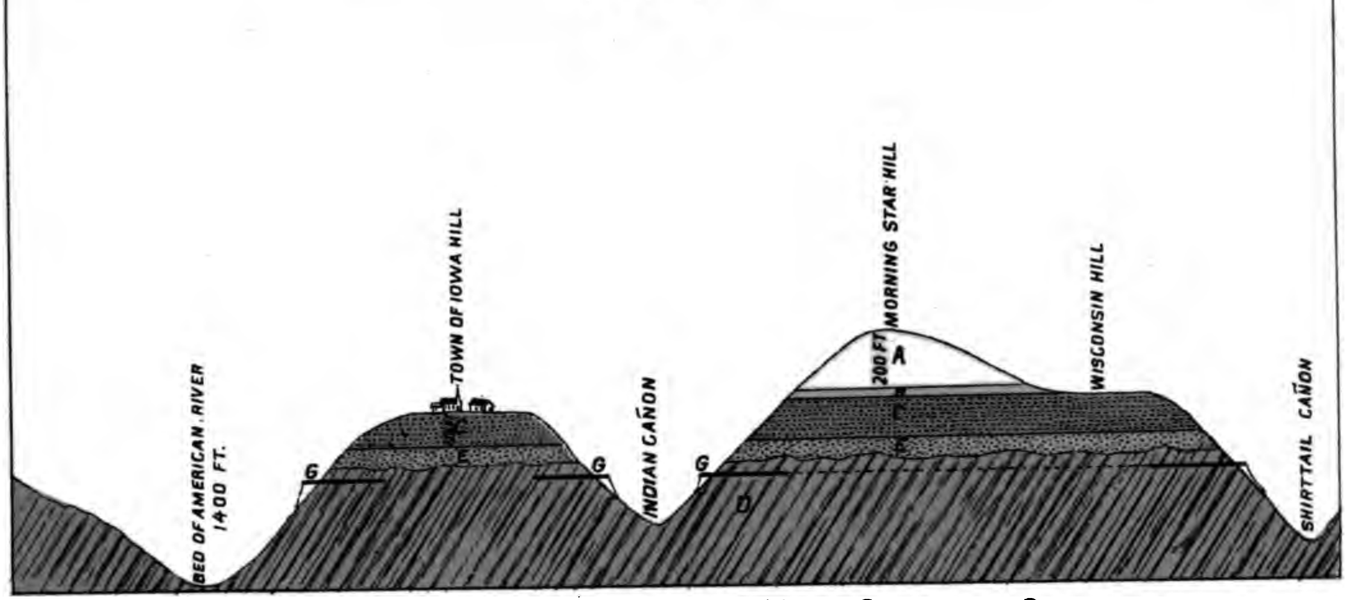
PLATE 6



CROSS-SECTION OF RED POINT AND DAMM CHANNELS.

- **A.** Volcanic Capping.
- **B.** Red Point Channel.
- **C.** Damm Channel.
- **D.** Slate Bed-rock.
- **E.** White Quartz Gravel on Rim.
- **F.** Working Tunnels.

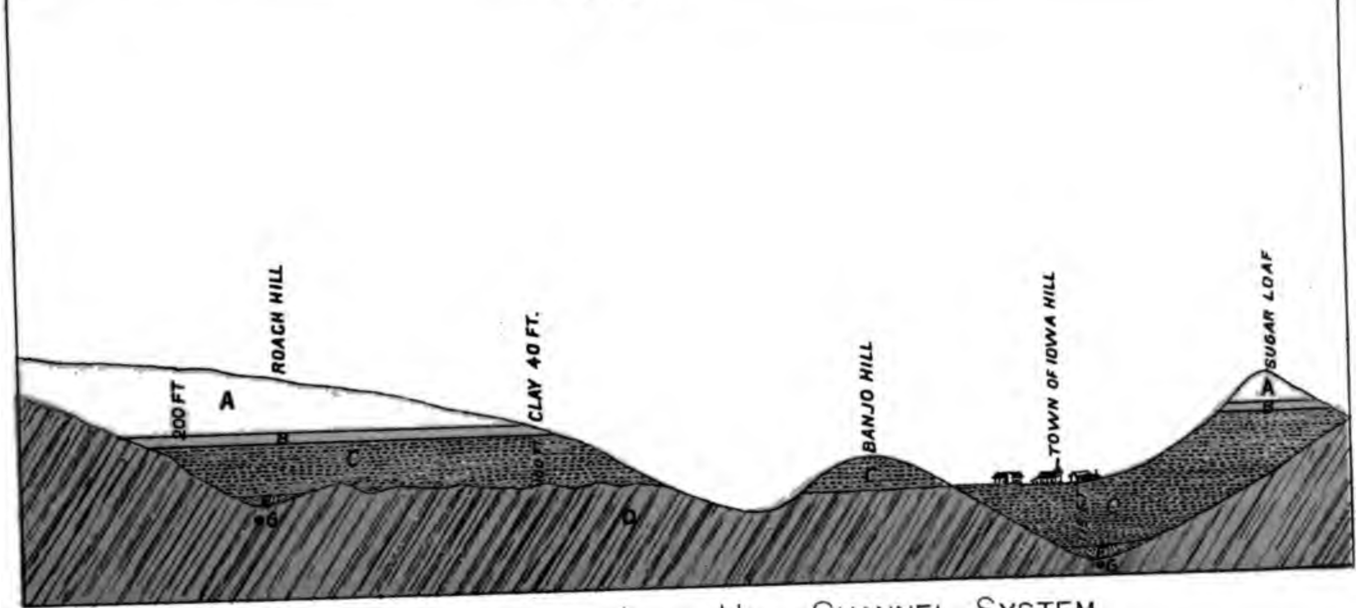
PLATE 7



LONGITUDINAL SECTION OF IOWA HILL CHANNEL SYSTEM.

A. Volcanic Capping.
B. Pipe Clay.
C. Mixed Quartz Gravel, generally fine.
D. Slate Bed-rock.
E. Blue Gravel of Iowa Hill main Channel.
G. G. Tunnels.

PLATE 8



CROSS-SECTION OF IOWA HILL CHANNEL SYSTEM.

A. Volcanic Capping
B. Pipe Clay.
C. ... Gravel.
E. Blue Channel, Wolverine Channel.
F. Main Blue Gravel, Iowa Hill Channel.
G. G. Tunnels.

METHODS OF MINING.

The mining of the deep placers may be divided into two classes, viz.: drift mining and hydraulic mining. As is well known, the hydraulic mining has been almost entirely restricted during the past six years by adverse legal decisions. This stoppage of hydraulic mining has given a great stimulus to drift mining, many of the enjoined hydraulic mines being now worked by drifting. But there are many gravel deposits that are peculiarly adapted to profitable hydraulic mining that are not susceptible of remunerative drift mining. In some mines the gold is more or less uniformly distributed throughout the gravel, and the lowest stratum is not rich enough to pay for the drifting, while hydraulicking can be profitably conducted.

The lithological character of the material filling the old river channels will determine which of the systems is to be pursued. Where a great depth of lava (as in the case of the Table Mountain formation, a section of which has been given) or other non-paying material is superimposed upon the auriferous pay gravel, drift mining must be resorted to. The exploitation of such large quantities of barren material would not be practicable, and by the system of drift mining this is obviated. In some places there is a concentration of the gold in a stratum immediately overlying the bedrock, while the rest of the deposit carries an amount of gold too small to admit of profitably hydraulicking the entire deposit. When such is the case, recourse is had to drift mining. Again, lack of grade, lack of dump, or the absence of other conditions requisite for hydraulic mining, make it necessary to adopt drift mining instead of the hydraulic system.

In drift mining, the deposit is worked through a shaft or through a bedrock tunnel. The latter system is preferable and is adopted where the topography of the district admits, inasmuch as the necessity of draining the mine by pumping and of elevating the gravel is obviated. Fortunately, the topographical features are often favorable to the working of the deposits by tunnels. To reach the gravel deposits, a bedrock tunnel is run from some neighboring cañon through the rim-rock to a point beneath the gravel at which exploitation is to begin. *In drift mining, where worked through tunnels, it is vitally important to determine the approximate elevation of the gravel deposits, so as to run the tunnels sufficiently below the gravel to admit of working the deposit by gravitation. When the tunnel is run above the bedrock (except in cases where a false bedrock is adopted as working level), the deposit cannot be worked without elevating the water and gravel.

This is a costly and rarely practicable system of mining. Many disastrous mining failures have attended the faulty location of a bedrock tunnel. The bedrock tunnels are sometimes more than a mile in length. These tunnels cost from $5 to $40 per running foot, $12 to $16 being about the average, depending upon their dimensions, and chiefly upon the hardness of the ground. Power drills are generally used in running long tunnels. While in rock of medium hardness there is no economy in the use of these drills; in effecting a saving of time they are valuable. On the other hand, where the rock is exceptionally hard, the use of air drills effects

* Within a few years, the projection of the ancient channel upon maps to distances of several miles beyond the nearest visible point has been correctly made by engineers, who have made a specialty of this class of engineering work. In this connection the delineation of the Red Point Channel (see sketches 3, 5, 6) and the determination of the best site for a tunnel to open up the gravel deposit, is deserving of note. This successful and very creditable work was done by Messrs. Ross E. Browne, John B. Hobson, and Charles Hoffman. (See article by Russell L. Dunn, in Report of State Mineralogist 1888.)

the saving both of money and time. The dimensions of the tunnels, where run by hand, are generally about five feet wide and six and one half feet high. Where run by air drills, they are often as wide as eight to ten feet, and from seven to eight feet in height. Sometimes, to make speed, two drills are worked at the same face, in which case the width of the tunnel is from eight to ten feet. From one hundred and fifty to four hundred feet of tunnel may be run monthly by using air drills. The tunnel, where run in bedrock, but rarely requires much lagging and timbering. When run in gravel, this is an expensive item of cost. From the tunnel, upraises are made into the gravel deposit. These upraises are one hundred and fifty to two hundred feet apart, and serve as chutes. From the top of the upraises, gangways are run through the gravel, and the deposit is blocked out by cross drifts, and exploited in a manner similar to the working of horizontal seams of coal. The gravel is usually worked to a height of five to eight feet. Where the bedrock is soft, and of a laminated character, it is taken out to a depth of from one half foot to four feet, and washed with the gravel. The large bowlders are picked out and stowed back in the excavated ground. The gravel is wheeled, or brought by small cars, to the gravel chutes, leading to the bedrock tunnels. Through these chutes it is dumped into the cars in the main tunnel. These cars, where the tunnel is long, are drawn (six to ten constituting the train) by animals, or by locomotives,* and emptied automatically upon "dumping chairs" near the mouth of the tunnel. The cars carry from one to two tons of gravel. The best grade for the tunnel is three to four inches per hundred feet.

The gauge of the track is from sixteen to twenty-two inches. T rails, weighing from twelve to thirty pounds, are generally used, but in some mines wooden rails, covered with strap iron one to two inches in width by one quarter to one half inch thick, are used. T rails are unquestionably preferable. Track of this character can be laid at from 50 to 60 cents per foot. In the gangways through the gravel, the track is a temporary structure that can be conveniently moved from the abandoned gangways.

Outside of the tunnel the track divides into three branches. One track leads to the waste dump, where the waste rock from the bedrock tunnel, etc., is dumped. Another track leads to a small "prospect" bin, into which the gravel to be tested as to its richness is discharged. The third (main) track leads to the main gravel dump.

EXTRACTION OF THE GOLD.

The gold is extracted either by:

First—Sluicing, when the gravel is "free," *i. e.*, not cemented.

Second—By the milling process, when the gravel is cemented.

The process of sluicing is essentially similar to the washing of the gravel in hydraulic mining. The cars are run on to dumping chairs, which dump the gravel automatically. The gravel falls into a wooden bin, heavily boarded, and sometimes covered with light sheet iron. At the bottom of the bin is the head of the line of sluices, into which the gravel is directed by the slope given to the sides of the bin. This structure is generally covered over to protect the men from the inclemency of the weather. The water is introduced by a pipe connected with the water

* At Bald Mountain the gravel was brought from the mine a distance of over seven thousand feet, by a locomotive, drawing a train of eighteen cars, carrying two tons per car. The locomotive weighed seven and one half tons. The trip was made in five minutes. Anthracite coal was used for fuel. According to Superintendent Wallis, the relative costs of transportation at Bald Mountain were: By man power, 21 cents per carload (two tons); by mule, 9 cents per carload; by locomotive, $4\frac{3}{4}$ cents per carload.

tank, and the gravel is washed into and through the sluices. Where the water supply permits, the gravel is washed once a day. A permanent and sufficient water supply is very desirable for washing the gravel, but at many mines there is a scarcity of water, in consequence of which the gravel can only be washed at irregular intervals.* Sometimes the gravel is stored in bins for several months, awaiting available water; at some places the drain water from the mine is stored in a large water tank near the head of the sluices, and when a sufficient quantity has accumulated, is used for washing the gravel. Occasionally, water from this source is sufficient for this purpose, but usually the supply has to be supplemented by water from elsewhere. It requires from one sixth to one twelfth of an inch of water to wash a cubic yard of "free" gravel. The sluices are wooden boxes from eighteen to twenty-four inches in width and depth, and usually twelve feet in length. They are set on a grade of eight to eighteen inches per twelve feet, and paved usually with iron riffles that may be readily removed. The length of the string of sluices is rarely more than a few hundred feet—most of the gold is caught within one hundred feet of the head of the bin when the gravel is very free. Drops and undercurrents should be more frequently used in this connection than is the practice, and more quicksilver added to the sluices. At many mines, where the gravel is somewhat cemented, the tailings are impounded below the sluice and allowed to slack, after which they are rewashed by a second string of boxes below the dam.

The milling process is adopted when the conglomerate is too strongly cemented to be disintegrated (as in the sluicing process) by means of water. The gravel must then be crushed in a gravel mill, which, in most respects, is similar to the mills employed in the reduction of gold ores. The gravel is crushed through coarse screens, three sixteenths of an inch mesh in diameter, and is mostly caught in the battery by amalgamation. Outside copper plates, as in gold milling, are also used. The capacity of gravel mills is from five to twelve tons per stamp in twenty-four hours. It takes from one third to one fourth of an inch of water to mill a cubic yard.

Mills for gravel should have double discharge mortars. They should have rock breakers and self feeders. No attempt is made to save the sulphurets, which are usually found in the conglomerate. These sulphurets (and magnetic sands) are auriferous, but generally not rich or abundant enough to pay for saving. The cost of mining by this method is, of course, exceedingly variable.

COSTS OF DRIFT MINING.

Where the deposit is worked by tunnels and the gravel is free (not cemented), under favorable conditions gravel may be mined and washed for 90 cents to $1 25 per cubic yard; where the gravel is cemented and requires much blasting the cost of mining will be considerably increased. Such gravel also has to be milled, further enhancing the cost from 20 cents to 40 cents per ton. Under favorable conditions of mining and milling, cemented gravel may be worked at a cost of from $1 75 to $3 50 per cubic yard.

The mines are ventilated in the most improved systems by blowers (Baker's, etc.) run by machinery. This is a cheaper and far more effective system than ventilation by means of air shafts and air drifts kept open for that purpose. The latter system costs from $3 to $5 per lineal foot of channel worked, while the former costs less than 50 cents.

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*The dumps where the gravel was stored awaiting water for washing, at the Bald Mountain Mine, had a capacity of twenty-six thousand and sixteen thousand carloads, respectively.

EXAMPLES OF DRIFT MINES.

May Flower.—Situated in Placer County. From December 11, 1888, to September 24, 1889, the company's twenty-stamp mill crushed thirty-three thousand seven hundred and eighty-seven tons of cemented gravel, which yielded $272,616 50, or $8\frac{6}{100}$ per ton. But few mines have as rich gravel as this. The monthly expenses of the company ranged from $10,000 to $13,000. A lineal distance on the channel of one thousand six hundred and twenty feet yielded the thirty-three thousand seven hundred and eighty-seven tons referred to.

Hidden Treasure.—Situated on the Damascus Channel (see sketches), Placer County. The gravel worked is not cemented, but is cheaply mined and is "free milling;" *i. e.*, it does not require crushing. This ground is "picking" ground, requiring no blasting. The timbering expense is, however, much greater than that of the cemented gravel mines. From February 27, 1888, to June 30, 1888—one hundred and eight working days—the figures are:

	Per Load—One Ton.	Total.
Gold yield	$1.2347	$39,821 53
Wages	$0.7202	$23,528 00
Contracts	.1077	3,464 78
Expense, material, etc	.0957	3,086 94
Total expense	$0.9236	$30,079 72
Profit	.3111	9,741 81

Number of days' labor, 11,164.50. Number carloads gravel, 32,252.

For the eleven years, 1877 to 1887, inclusive:

Receipts.

Gold yield	$879,523 27
Receipts from other sources	19,176 16
Total	$898,699 43

Expenditures.

Wages	$490,297 64
All other expenses	137,064 35
Dividends	268,092 00

The cost per carload ($0.9236) is exceptionally low, as under ordinarily favorable conditions $1 50 to $1 75 a carload is as low a figure as can be anticipated, and in most of the mines the cost is from $2 to $3.

The yield of this mine last year was, approximately, gross: $81,000; expenses, $51,000; net, $30,000. The value of the gravel per ton was $1 56. One hundred and twenty men were employed.

Bald Mountain Mine.—Situated in Forest City, Sierra County. The owners of this property invested $20,000 in opening up the mine, with the following gratifying results:

Year Commences July First—	Carloads.	Gross Yield.	Dividends.
1872–1873	50,168		
1873–1874	65,782	$544,000 00	$284,000 00
1874–1875	79,990		
1875–1876	100,080	296,341 76	150,000 00
1876–1877	98,044	235,803 57	70,000 00
1877–1878	106,160	269,755 00	120,000 00
1878–1879	90,274	164,909 00	40,000 00
1879–1880	86,378	188,892 40	60,000 00
1879–Oregon Creek		3,000 00	
	676,876	$1,702,701 73	$724,000 00
July, 1880		16,914 38	20,000 00
July, 1880, 920 feet, Oregon Creek		9,000 00	
August 1, 1880		$1,728,616 11	$744,000 00
From June, 1881, to June, 1887 (mine closed down, having been worked out)		803,124 00	240,000 00
Totals		$2,531,740 11	$984,000 00

In addition to this, upwards of fifty thousand was taken from the reworked tailings which had been run into the cañon to slack (disintegrate the cemented gravel). From 1881 until 1887 (when operations were discontinued) the gravel output was from sixty thousand to one hundred and seven thousand carloads (one and one fourth tons per car) annually. The costs of mining, washing the gravel, and general expenses, etc., were from $1 22 to $1 44 per carload of extracted gravel. During 1881–82 the gravel yielded 50½ cents per square foot of ground removed. The Ruby Gravel Mine, on the same channel as the Bald Mountain, has a pay lead of from fifty to three hundred feet in width (including the benches of gravel). Under the economical management of Mr. Pichoir, gravel is extracted from the breasts twelve thousand feet from the mouth of the tunnel, and washed at a total cost of only $1 25 per carload of one and one fourth tons. This gravel is free, and requires no blasting.

The record for this channel to the year 1880 is as following—three thousand eight hundred and fifty feet worked:

Gross yield	$1,788,000;	$465 per lineal foot of channel.
Working expenses	923,000;	$240 per lineal foot of channel.
Profit (including plant)	$865,000;	$225 per lineal foot of channel.

This company owned seven thousand five hundred feet of channel.* The claim was worked out about three years ago. In full operation the mine employed from one hundred and twenty-five to one hundred and seventy-five men.

HYDRAULIC MINING.

The recent suppression of hydraulic mining by judicial decisions, has reduced the annual gold product of California by at least $10,000,000; has thrown thousands of men out of profitable employment, and has withdrawn enormous sums of money from circulation in the various channels of trade. Nor have the hardships which resulted from this been confined to persons directly connected with mining enterprises; being felt generally throughout the community, and they have fallen to a great extent on the very persons whom the decisions in question were designed to protect. For-

* Lava flow carried away five hundred feet of this channel.

tunately, however, the interdependence of the various industries of the State in this respect is becoming generally recognized, and thoughtful men, of whatever profession, are awakening to the desirability of rehabilitating the hydraulic mining of the State. It is greatly to be hoped that some method will shortly be devised for the accomplishment of this end, and for the effective prosecution of hydraulic mining, *in a manner which will at the same time insure to the farming interests of the State the protection to which they are entitled, and preserve the navigable rivers of the State as well.*

In general, hydraulic mining consists in the disintegration of the auriferous alluvia, by propelling a heavy jet of water under pressure upon the bank, and in washing off the gravel in sluices in which is distributed mercury. The gold forms an amalgam and remains caught. The determining conditions of the profitable prosecution of hydraulic mining are:

First—Attainment of a large supply of water under a high pressure at not too great a cost.

Second—Facilities of obtaining the grade requisites for the sluices, and the dump for the refuse or "tailings."

MEASUREMENT OF WATER.

The method by which water is measured in the mining counties of California is that in vogue in Italy and Spain.

An aperture, whose sectional area represents a certain number of square inches, is cut through an upright or vertical board, which forms a portion of a confined box. The amount of water discharged through this orifice, divided by the number of square inches of the sectional area of the orifice, is called the "miner's inch."

The quantity of water represented by the "miner's inch" varies throughout the State by reason of the difference in pressure (*i. e.*, the height of the surface of water above the orifice), the thickness of the board through which the orifice is cut, etc., and ranges from two thousand to two thousand six hundred cubic feet per twenty-four hours of flow. The quantity of water discharging through an orifice one inch square, through a two-inch board, constitutes the "miner's inch" most generally adopted throughout the State. The quantity of water discharged under the above conditions for ten hours is called the ten hours miner's inch. The twenty-four hours miner's inch is that understood when not otherwise expressed. The miner's inch, as above described, is approximately sixteen thousand eight hundred gallons.

WATER SUPPLY.

The water used in hydraulicking is derived from the streams fed chiefly by the rains and melting snows. Where operations are conducted upon a comparatively small scale (the companies having no storage reservoir of any considerable capacity), the hydraulicking season is about coextensive with the rainy season, rarely being prolonged more than a month or two after the cessation of the rains. Under such conditions five to six months is about the duration of hydraulicking.

NOTE.—In some localities in California, Idaho, Montana, and Colorado, "booming" is practiced. This system is adopted where there is a scarcity of water, or where the gravel is too limited in extent, or too poor in grade, to justify the expense of bringing in a permanent supply of water for hydraulicking. It consists in accumulating a supply of water in a reservoir at the head of the gulch where the gravel is to be washed, and discharging (usually automatically) the entire volume of water at once, so that the rush of the water carries off the gravel into sluices disposed for that purpose. Some of the gold is caught in the sluices—a great part obviously is carried off. Booming is confined to the gulch gravel.

NORTH BLOOMFIELD MINE, NEVADA COUNTY.

...discharge of two thousand five hundred miner's inches. Material is washed through bedrock cuts to the sluices. ...sluices are not visible in the artotype.

BOWMAN (MAIN) DAM, NORTH BLOOMFIELD COMPANY.

BLUE TENT SYSTEM.
Flumes and ditches carried around steep and rocky mountain side.

Companies hydraulicking more extensively have storage reservoirs commensurate with the magnitude of their operations. Such companies are enabled to continue their piping with but little interruption during the entire year. The reservoirs constructed for mining purposes (chiefly for hydraulic mining) on Yuba, Bear, Feather, and American Rivers have an aggregating storage capacity of about fifty billion gallons, which is about twice as much as the Spring Valley Water Company's system.

The source of water supply of the North Bloomfield Gravel Mining Company, the Milton Mining and Water Company, and the Eureka Lake and Yuba Canal Company (consolidated), is about the headwaters of Big Cañon Creek and Middle Yuba River in Nevada and Sierra Counties. The catchment area embraced in those sections represents in the aggregate 68.6 square miles. There are eleven principal reservoirs varying in area from ten acres to four hundred and eighty-seven and one half acres (high water area) each, and having a capacity of from $2\frac{1}{2}$ to 796.7 million cubic feet. The total area of the reservoirs of these companies is over eleven thousand six hundred acres (at high water mark) with a total capacity of over two billion one hundred and ninety-five million cubic feet.

In order to obtain efficient head or pressure, it is often necessary to bring the water from great distances. To overcome the topographical obstacles, considerable engineering skill is sometimes required. In Butte County the bracket flume of the Miocene Ditch Company is something unique in hydraulics.

In order to obviate the construction of a trestle some one hundred and eighty feet high, the water is conveyed in a wooden flume (four feet wide and three feet deep) around a bluff three hundred and fifty feet in height. The flume was suspended upon brackets made of T rails, bent in the form of a reversed L (⅃) soldered into holes previously drilled into a solid vertical escarpment; men were swung down by ropes to drill these holes.

In another place in this line of ditch is a piece of trestlework one thousand and eighty-eight feet long and eighty feet high.

Herewith is given the statistics of the water companies in the central mining counties of the State. The water of these companies is used principally for mining purposes.

Water for hydraulicking costs 5 to 25 cents an inch, when purchased from water companies; 10 to 15 cents is the usual price paid by hydraulic mining companies.

In 1877–78 the Bloomfield Company used eight hundred and fifty-five thousand miner's inches (twenty-four hours inches) of water, at a cost of $2\frac{6}{10}$ cents per inch.

La Grange Ditch and Hydraulic Mining Company, Stanislaus County. Water from Tuolumne River, eighteen miles from mine. Length of ditches, twenty-five miles. Dimensions: top, nine feet; bottom, six feet wide; depth, four feet; capacity, two thousand seven hundred miner's inches per twenty-four hours; grade of ditches, seven to eight feet per mile. Cost of ditches, etc., $450,000.

Tuolumne County Water Company, Tuolumne County. Water from south fork of Stanislaus and tributaries. Miles of ditches, one hundred and twenty-five (fifty miles not in use now); six miles of flumes. Grade, ditches, eleven to thirty-two feet per mile. Dimensions of ditches: width, bottom, seven and a half to eleven feet; top, eleven to fifteen feet; depth, four feet. Ditches cost, on average, $4 50 per yard; flumes, $14 per yard; and pipes, $6 per yard.

Union Water Company, Calaveras County. Water from north fork of Stanislaus River. Forty miles of ditches; capacity, two thousand five

hundred miner's inches; water grade, three to twenty-five feet per mile. Total cost of plant, $200,000.

Mokelumne Hill and Campo Seco Ditch Company. Water from headwaters of Mokelumne River. Ditches, over one hundred miles; grade, eight to sixteen feet per mile; capacity of ditch, one thousand five hundred inches. Cost, about $500,000.

El Dorado Water and Deep Gravel Mining Company, El Dorado County. Main reservoir, Silver Lake, Amador County. Main ditch, forty miles; tributary ditches, seventy miles; total ditches, one hundred and ten miles; one mile of flumes; three miles of pipes. Dimensions of ditches: top, ten feet; bottom, six feet; depth, four feet; grade of ditches, four feet to mile; flumes, grade, one and one third to two and one half feet per mile; water delivered, four thousand inches. Reservoirs cost $45,000. Total cost of plant, $600,000.

California Water and Mining Company. Water from Loon Lake and Pilot Creek, in El Dorado County; two hundred and fifty miles of ditches; grade, six to sixteen feet per mile. Dimensions: top, three and one half to eight feet wide; bottom, two to five feet wide; one and one half to three feet deep; water supplied by ditches, one thousand two hundred inches; flumes, two and one half miles. Total cost of plant, $600,000.

Park Canal and Mining Company. Water from different branches of Cosumnes River; ditches, two hundred and ninety miles; flumes, eight miles; pipe, one mile; grade of ditch, one half to sixteen feet per mile. Dimensions: top, eight feet wide; bottom, five feet wide; two and one half feet deep; capacity of ditches, two thousand two hundred inches. Reservoirs cost about $60,000. Total cost of plant, $2,000,000. Ditches cost $10 per rod; flumes, $12 to $14 per rod; pipes, $2 50 to $4 50 per yard.

Iowa Hill Ditch Company, Placer County. Water from North Fork of American; twenty-five miles of ditches; capacity of ditch, three thousand inches. Plant cost $200,000.

North Bloomfield Company, Nevada County. Length (including reservoirs) of ditches, one hundred and fifty-seven miles; capacity, three thousand two hundred inches; grade, twelve to sixteen feet per mile. Dimensions of ditch: top, eight and two thirds feet wide; bottom, five feet wide; depth, three and one half feet. Cost of plant, $708,841. It costs $13,463 per year to keep the reservoirs and ditches in order.

Milton Company (including reservoirs). Length, eighty miles; grade per mile, twelve to twenty-five feet. Dimensions: top, six feet wide; bottom, four feet wide; depth, three and one half feet; capacity, three thousand inches. Cost, $391,579.

Auburn and Bear River Canal Company, Placer County. Seventy-five miles of ditches; capacity, three thousand inches. Cost, $350,000.

Amador Canal, Amador County. Ditches, sixty-six miles; capacity, two thousand inches. Cost, $400,000.

Brandy City. Ditches, seventeen miles; capacity, two thousand inches. Cost, $150,000.

Buckeye Company, Trinity County. Ditches, thirty-five miles; capacity, two thousand five hundred inches. Cost, $120,000.

Dardanelles Ditches, Placer County. Seventeen miles; capacity, three thousand inches. Cost, $125,000.

Del Norte Company. Ditches, ten miles; capacity, two thousand inches. Cost, $40,000.

Gold Run Ditch Mining Company. Ditches, twenty-six miles; capacity, two thousand five hundred inches. Cost, $150,000.

SPRING VALLEY MINE, BUTTE COUNTY.
... streams piping. Gravel is washed into the deep bedrock cut which leads to the tunnel seen in background, right hand side ...

ɜ York and Liberty System, Nevada County, Cal. Ditches, thirty-les; capacity, three thousand five hundred inches. Cost, $150,000.

ma Water and Mining Company. Ditches, sixteen miles; capacity, ıousand five hundred inches. Cost, $390,000.

nix Ditch Company. Ditches, one hundred miles; capacity, four ıd inches. Cost, $880,000.

ırs' Ditch, Butte County. Ditches, thirty miles; capacity, two thou-ıches. Cost, $75,000.

ornia Water Company. One hundred and twenty-five miles; capac-r thousand five hundred inches. Cost, $550,000.

ka Lake and Yuba Ditch Company. Length of ditches, one hun-ıd sixty-three miles; capacity, five thousand eight hundred inches. 23,342.

ı Yuba Ditch Company. One hundred and twenty-three miles of ; capacity, seven thousand inches. Total cost of plant, $1,100,000.

rtsville Ditches. Capacity, five thousand inches; grade, nine feet e; cost, $1,000,000. Dimensions: top, eight feet wide; bottom, five le; depth, four feet.

ıg Valley and Cherokee. Ditches, length, fifty-two miles; capacity, ıusand two hundred inches. Cost, about $500,000.

lricks. Ditches, length, forty-six and one half miles; grade, six to feet per mile. Cost, $136,150.

Tent. Ditches, thirty-one miles; capacity, two thousand one hun-.ches. Cost, $200,000.

n feasible, ditches are used as conduits in preference to flumes or as the cost of construction and of maintenance is less than that flumes or pipes.

ome places, the topography of the country, the character of the (hardness, porosity, etc.), or other conditions, render the use of more economical. Flumes are usually of smaller sectional area ıe ditches, but are given more grade (twenty to forty feet per mile) ıpensate for the reduced area. Flumes cost from $1 to $2 per 'oot.

'herokee, in Butte County, the water is conveyed across a deep by an inverted siphon of wrought iron. The diameter of the pipe y to thirty-four inches, and its greatest thickness, where subjected ·essure of eight hundred and eighty-seven feet (three hundred and four pounds per square inch), was No. 00 iron, Birmingham gauge, ıches.

DUTY OF MINER'S INCH.

duty of a miner's inch of water is the quantity of material which nount of water is capable of moving. Obviously, the duty of a ı inch will vary greatly, depending as it does on the quantity of ısed, the pressure of the water, the character of the material washed, ɜ grade and width of the sluices.

NAME OF STREAM.	Quantity of Water Used in Mining and Discharged into Beds of Rivers in Twenty-four Hours—Inches.	State Engineer's Estimate of the Duty per Inch—Cubic Yards.	Amount Cubic
Table Mountain or Dry Creek	833,250	3½	
Butte Creek	24,000	3	
Feather River	1,259,363	3½	
Yuba River	5,458,171	3½	1
Bear River	1,117,082	3	
Dry Creek, No. 2	44,229	3	
American River	1,914,500	4½	
Totals	10,650,595	* 3.6	3

* Average.

These estimates are less than the actual results. Other condition the same, the duty of a miner's inch increases rapidly with an inc grade of the sluices. Le Conte says the transporting power of wat the sixth power of its velocity.

At Hobson's mine, in Placer County, piping a bank one hundre twenty feet high, of very light free gravel containing no cement, usi hundred inches of water, under a pressure of three hundred and six with a twelve-inch grade (twelve inches to a box of twelve feet) for the duty of a miner's inch was twenty-four cubic yards. At the mine, with the same grade, same quantity and pressure of wat where the gravel was coarse and cemented, the duty was reduced yards.

Under the same conditions of gravel bank and water supply as r to in the first example given, but where the grade of the sluice w creased to eighteen inches a box, and where iron riffles were used i of rocks, the duty of thirty-six cubic yards per inch was attained. results are exceptionally high in hydraulicking. At Wisconsi Placer County, piping light top gravel with a grade of twelve inch box of twelve feet, with five hundred inches stream, the duty of a r inch was ten cubic yards, while only three cubic yards of botto cemented gravel were washed under the same conditions.

At the North Bloomfield, in washing one million five hundred th cubic yards of top gravel, the duty of a miner's inch was 5.39 yards.* In washing seven hundred and ten thousand cubic yards underlying gravel (to height of sixty-five feet above the bedrock) th of an inch was but 2.34 cubic yards. In the latter case, thirty-fiv feet of water were required to move one cubic foot of gravel.

DUMP, ETC.

Less indispensable even than a good water supply is the availal upon the property to secure sufficient grade for sluicing and satis dumping ground for the tailings. Much room is required below th upon which to deposit the debris, where operations are conducte large scale. Where upwards of two millions of cubic yards of m

* At Bloomfield, twenty-four hours miner's inch equals two thousand two hund thirty cubic feet, the duty per miner's inch was ten cubic yards, while under the sa ditions of pressure and grade of sluices, piping the underlying heavier cemented *gravel, the duty* was but four cubic yards.

HOBSON MINE, PLACER COUNTY.

Monitor playing five hundred miner's inches under head of three hundred and sixty feet. It will be seen that the bottom gravel is much coarser than the gravel higher in the bank.


WATER POWER DERRICK FOR REMOVING HEAVY BOWLDERS.


MONITOR.

are moved annually, the mine, obviously, must have an extensive outlet for the debris. Deep cañons are the most favorable sites for this purpose.

In order to utilize the pressure due to the elevated position in which the water is brought, with respect to the gravel to be washed, the water is conducted from the ditches into a tank called the "pressure box" or "bulkhead." From the pressure box or bulkhead, by means of a feed-pipe (main pipe), the water is brought to a distributer. The size of the feed-pipe is determined by the quantity of water to be used. Twenty-two-inch (in diameter) mains are generally used in the larger hydraulic workings.

The pipes are made of wrought-iron, the thickness of which increases with the diameter of pipe, and the hydrostatic pressure to which the pipe is subjected, Nos. 16, 14, 12 (Birmingham gauge). These numbers correspond to thickness of .065, .083, 1.09 inches, respectively. To prevent the pipes from corroding, they are coated with a preparation of asphalt and coal tar. The pipes are made in lengths of twenty feet, and jointed together in stove-pipe fashion, rivets being rarely used.

The "distributer"* is a cast-iron box which serves the purpose of a hydrant, and by means of valves enables the partition of the stream of water and the diversion of the branch streams into two or more pipes, whereby more than one part of the gravel bank can be simultaneously hydraulicked.

From the distributer the streams are piped to the "monitors" or "giants." These are the discharge pipes which concentrate the stream and enable its projection upon any desirable point. The giants and monitors are labor saving. Before their introduction at North Bloomfield, there were ten to fifteen streams playing, while now one stream, tended by one man, does as much work.

The "nozzles" of the monitor are from four to nine inches in diameter. Two or more monitors are employed, depending upon the magnitude of the workings. The streams played upon the bank are one hundred or more feet in length. The large mines have a dozen or more monitors, but rarely have enough water to supply at once more than four or five monitors.

The disintegrating power of the jet, which at the larger mines equals one thousand to one thousand five hundred inches of water (one thousand five hundred to one thousand seven hundred and fifty cubic feet per minute), weighing sometimes upwards of one hundred thousand pounds, under pressure of one hundred and fifty feet to four hundred and fifty feet, is enormous. Yet, notwithstanding this, the gravel is sometimes so tenaciously cemented that assistance of powder becomes necessary to shatter or break up the bank preparatory to its disintegration by water.

It is desirable to get the monitor or giant as near the bank as is consistent with the safety of the miners and the machine, in order to obtain the full force of the stream. Where the banks are high—over two hundred feet or so—they are accordingly usually worked in benches of from one hundred and fifty feet to two hundred feet in depth.

The system of "bank blasting" generally in vogue is as follows: A small level, or drift, is run into the bank at right angles to the face of the bank, and from the end of this drift crosscuts are driven parallel to the bank (at right angles to the drift). The drifts will form a T-shaped excavation. The length of the main drift will vary from twenty to one hundred feet, and in the cross-drifts, of which there may be two (forming a ╤), the kegs of powder are placed. The cubical contents of the portion of the bank to

* Owing to the liability to break, and their unwieldiness, the cast-iron distributers have, in many places, been displaced by sheet-iron branch pipes, or tees, which have cast-iron gates.

be blasted, the tenacity of the material of the bank, etc., will determine the length of the powder drifts and the quantity of powder to be used. From a few dozen to a thousand or more twenty-five-pound kegs of black blasting powder * are ignited in one blast. The drifts are well tamped, and the charges are simultaneously fired by means, generally, of a high-tension electrical machine.

Where the banks are worked in "benches" or stopes, vertical shafts ten to twenty feet deep are sunk from the surface of the deposit, short drifts are run from the bottom of the shaft, forming an inverted T (⊥), and the powder charged, tamped, and fired as above. Very much lighter charges are used in this kind of blasting. A slow lifting powder is generally used for bank blasting, while the nitro-glycerine explosives are used for blasting the bowlders, trees, etc., which were washed down into the pit or open space on the bedrock left after washing away the gravel, etc.

The second condition prerequisite to the successful working of the hydraulic mine is the attainment of the grade necessary for the treatment of the detrital material piped from the bank.

To get the requisite grade for the sluices, and, at the same time, to obtain a suitable place for the deposition of the debris from the washing out of the gravel bank, often involves the driving of a long bedrock tunnel.

The topographical features of the environs will determine the location of the tunnel. The mouth of the tunnel should be sufficiently below the bedrock of the deposit to be prepared for the contingency of a change in the grade of channel, whereby the tunnel might be placed above the level of the drainage and rendered practically useless. This difference of level also admits of the use of chimneys or shafts, connecting the surface of the bedrock of the channel with the face (interior end) of the tunnel, whereby a drop is obtained which facilitates the disintegration of the obdurate conglomerate. A line of sluices is laid in the tunnel.

The tunnels are from a few hundred to several thousand feet in length. The tunnel of the North Bloomfield Company, in Nevada County, is seven thousand eight hundred and seventy-four feet long, and its dimensions seven by eight feet. It cost about $500,000. The tunnels are from four to eight feet wide and from five to nine feet high.

The gradient to be given the tunnel will be determined by the fall available, the character of the material to be washed, etc. Tenacious material, such as very compact conglomerate, very indurated pipe-clay, etc., will require a high grade, and from ten to twelve inches per twelve feet would be advantageous.

The material "piped" from the bank is carried by the stream of water through bedrock cuts and sluices to the chimneys or shafts (where such exist).

The bedrock cut, as its name implies, is a trench carried in the bedrock from the upper end of the line of sluices to the gravel bank. These cuts are about as wide as the sluices, and are sometimes twenty to thirty feet deep. The gravel is washed into these cuts and thus is brought to the sluices. These cuts are not paved. Cuts require nearly twice as much grade as sluices.

SLUICES.

These are commonly called "flumes" in mining parlance, but the term "flume" should be restricted in meaning to a conduit for carrying water to be used in hydraulicking, while the term "sluice" in contra distinction

* Low-grade dynamite powder has almost entirely superseded black powder in bank blasting.

SLUICE LINE CONSTRUCTED ON CURVE.

A straight line is, of course, preferable for sluices

should refer to the boxes or troughs below the cuts through which the gravel is washed, and in which the gold is recovered.

These are a kind of water trough or box from three to six feet wide, and from two to three feet deep, and most generally twelve feet in length per box. From one hundred to several hundred boxes are used in a line of sluices.

PAVEMENTS.

To prevent excessive wear and tear of the sluices, they are lined with heavy planks on the sides and are paved with rocks and blocks which also serve as riffles to arrest the flow of the gold and amalgam. Iron rails ("T" rails from railroads), or wooden rails covered with bar iron, are placed longitudinally upon the bottom of the sluices and also serve as riffles.

Economic conditions will determine which of the styles of riffles are used. Rock riffles will wear longer than the other kind, lasting from three to six months, but require more grade to the sluices, and also a loss of more time in cleaning up and repaving the sluices.

Block riffles are made, where possible, of the "digger" pine (*Pinus sabiniana*) and other pine. Hard wood is not as good as the softer pine, which has the property of brooming up and thus presenting a better surface to arrest the gold and amalgam. They are square, varying in size from twelve to thirty inches, and in depth from ten to eighteen inches. The interstices of the pavement are filled with small stones. Block riffles last from two to four weeks in the average conditions of hydraulicking. Iron riffles considerably longer. Though more costly in the first instance, they are cheaper in the end, owing to their longer life and greater economy of time in being changed.

GRADE OF SLUICES.

Where top and poor gravel is being piped it is desirable to run it off as fast as possible. The grade upon which the sluices are set will be regulated by the available fall along the line of sluices, and by the character of the material washed. In some localities the adoption of minimum grades two to four inches per box is enforced by lack of fall. Not only does the use of such light grades greatly decrease the duty of water, but it involves a large increase in the expense of handling the rocks not capable of being sluiced upon such grades. The grade in general use is what is known as a six-inch grade (six inches to a box of twelve feet), but where practicable the use of grades from eight to twelve inches are more advantageous. Steep grades facilitate the thorough disintegration of the cemented gravel, and thereby effect a reduction of the length of sluice line, which would otherwise be necessary to insure this result.

It is best to have steep grades for the disintegration of the gravel and depend upon the undercurrents to save such gold as would not be deposited on account of the grades of this character. Steep grades are especially advisable where water is expensive or scarce. These sluices are several hundred and sometimes several thousand feet in length. (See "Loss of Gold.")

Some mines have a double line of sluices, so as to avoid loss of time in cleaning up and repaving sluices.

Sluices cost from $25 to $35 per box (twelve feet) at the larger mines. The Spring Valley Mine has three parallel lines of sluices, two and a half miles in length each.

GRIZZLIES AND UNDERCURRENTS.

When the available fall admits of it, one or more grizzlies and undercurrents are used along the line of the sluices.

A grizzly is a grating or framework of iron bars, laid parallel, with interstices between to allow the finer material to fall into the sluices, or undercurrents, below, while the coarser barren bowlders are screened off, as it were, and dumped outside of the flume.

It is desirable to get rid of the large bowlders as soon as possible, to prevent unnecessary wearing of the pavement of the sluices and waste of water in washing them; but where the gravel is much cemented the bowlders assist in its disintegration.

To remove the large bowlders (sometimes weighing several tons) from the bedrock and cuts, a kind of derrick crane is used. These bedrock derricks have a mast from eighty to one hundred feet high and a boom eighty to ninety feet long, and are modified in other respects to best adapt them to their employment in hydraulic mines. The actuating power of the derrick is, generally, a hurdy-gurdy. This is a peculiar kind of impact wheel, made to utilize water under high pressure. The water is projected through a nozzle tangentially to the wheel, upon the periphery of which are set radial buckets. The Pelton and Knight's wheels are examples. Under favorable conditions, the Pelton wheel will develop about eighty per cent of the theoretical power of the water.

The undercurrents are large boxes or tables, of various shapes and sizes, more commonly ten to twenty feet wide and forty to fifty feet long, which by the distribution of the water over larger surfaces makes the stream shallow and allows the deposition of the gold and amalgam upon the riffles with which they are paved. Block, rock, or iron riffles are used in the undercurrents. The fine material which falls through the interstices of the grizzly is usually carried to the undercurrents.

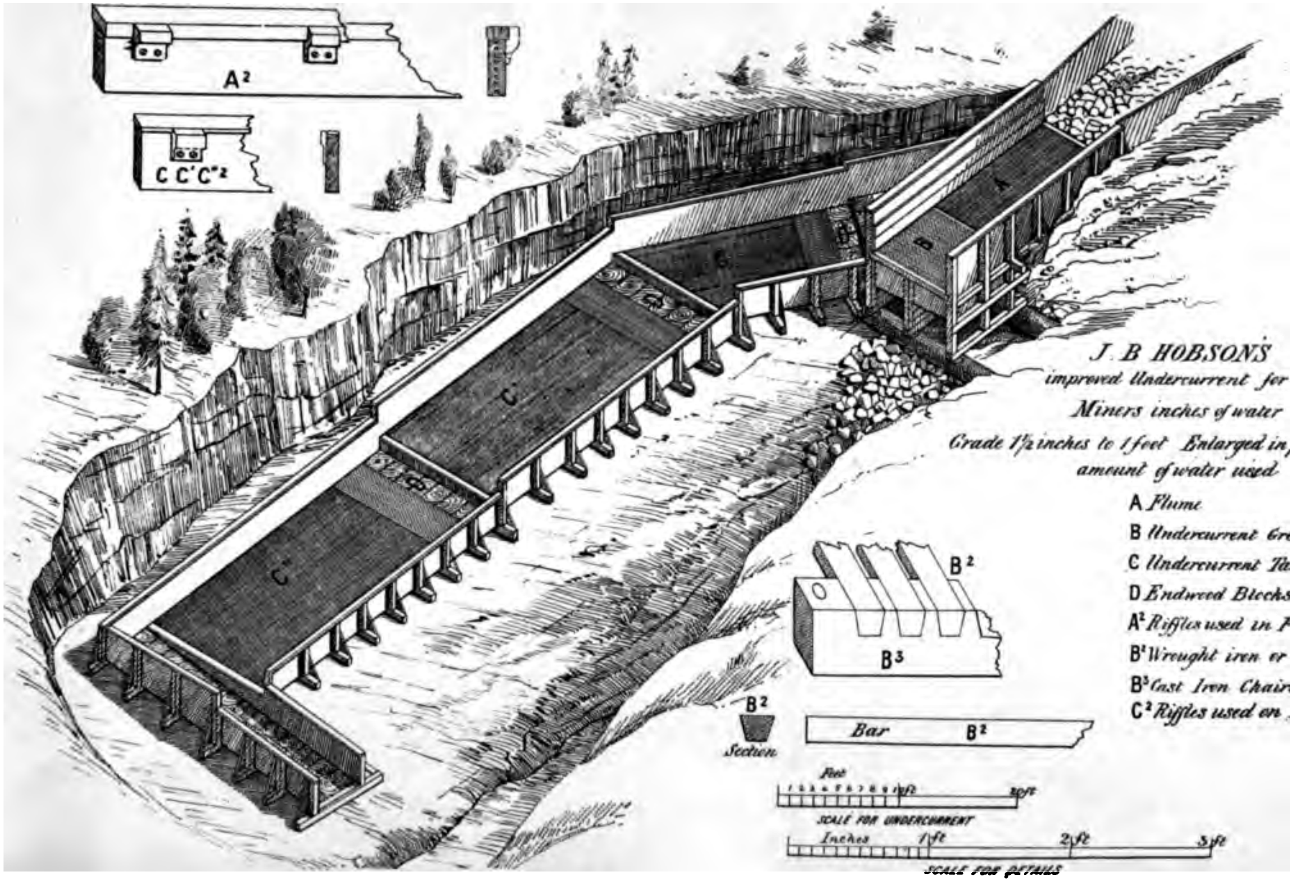
AMALGAMATION.

Quicksilver is added several times a day, in quantities depending upon the length of the sluices. The more quicksilver added the greater are the chances of catching the gold. The usual practice is to sprinkle the quicksilver in the sluices and undercurrents, the greater part being added near the head of the sluices. No quicksilver is added to the cuts. From the consistency of the amalgam, and the appearance of the quicksilver in the sluices (which are frequently inspected), the feeding of the quicksilver is regulated.

Two or four tons of quicksilver are often in process of manipulation at once at some of the large hydraulic mines, one part of it being in the sluices and another part on hand as amalgam. The upper portions of the sluices are cleaned up, generally once or twice a month, the middle portion less frequently, and the lower part only once a season.

With large "heads"* it is advisable to clean up frequently to prevent loss of amalgam through prolonged trituration. The upper part of the sluices for a distance of about two thousand feet ought to be cleaned up about every two or three weeks, where large quantities of gravel are washed. A gang of miners can clean up and repave a thousand feet of sluices in a day and night.

*The term "head" is often used in this connection to express the quantity of water used, as, for example, a head of five hundred inches, etc. It must not be confounded with the *hydrostatic head*, which the miners commonly designate as "pressure."



J. B HOBSON'S
improved Undercurrent for 600
Miners inches of water
Grade 1½ inches to 1 feet Enlarged in proportion to
amount of water used

A Flume
B Undercurrent Grating
C Undercurrent Tables
D Endwood Blocks 6" thick
A² Riffles used in Flume
B² Wrought iron or Steel bars
B³ Cast Iron Chairs
C² Riffles used on Tables

DROP FOR DISINTEGRATING GRAVEL, AND UNDERCURRENT.

... discharging from the undercur-

METHOD OF CARRYING FLUME ACROSS CAÑON BY IRON BRIDGE.

Also grizzly for removing large bowlders. Lack of room prevents introduction of undercurrent at this point.

CHEROKEE FLAT, BUTTE COUNTY.

CLEAN-UP.

In cleaning up the riffles are removed, a small stream of water is run over the sluices, and the gold and amalgam collected by scoops, etc. The amalgam is strained, cleaned, retorted, and melted. With the amalgam many of the minerals described before as existing in the gravels are found.

From 75 to 80 per cent of the total yield of amalgam is obtained in the first three hundred to four hundred feet of sluices. A small percentage of the gold, in the form of dust, comes from the bedrock cuts. The remainder of the gold recovered comes from the undercurrents and in the lower section of the sluices.

Total yield for the year 1877-78	$311,276 20
Near bank, from rock cuts in mine (dust)*	4.57 per cent.
Flume in tunnel (1,800 feet)	86.26 per cent.
Tunnel below flume (6,000 feet)	4.50 per cent.
Cut below tunnel (200 feet)	0.81 per cent.
Tail sluices (300 feet)	1.21 per cent.
From seven undercurrents	2.65 per cent.
	100.00 per cent.

The first undercurrent caught five times as much as the sixth, and nearly three times as much as the seventh undercurrent, which was of double size. This last yield, $947, induced the company to add another undercurrent.

The smaller mines use cup-shaped retorts, as used in the smaller gold mills, while the larger mines use retorts, such as are used in silver mills. Bullion from the hydraulic mines is notably very much finer than that from the quartz mines. This bullion will run from 850 to 980 fine. The bullion from the Australian gold gravels is much finer than that of California.

Silver is generally the debasing alloy, though where the grade of bullion is very low lead or copper are often found in the alloy. The value of the amalgam in the upper portions of the sluices is from $7 to $12 per ounce. The amalgam from the lower part of the sluices, from the undercurrents, is of less value, on account of the fineness (in texture) of the gold caught there. The amalgam from top gravel is poor for the same reason.

QUICKSILVER LOSS.

The loss of quicksilver is, under the average conditions, from 10 to 15 per cent of the quicksilver used; sometimes the loss is as great as 30 per cent, especially where the gravel is much cemented.

At the larger mines piping goes on night and day. Pitch bonfires are generally used to illuminate the works during the night, but at the North Bloomfield an electric light of twelve thousand candle power was used, and was found more effective and economical. At Cherokee two electrical lights, of eight thousand candle power each, are used.

GOLD LOSS.

The loss of gold in hydraulic mining varies according to the character of the gravel washed and the system of sluices, undercurrents, etc., in use. Where the gravel is a hard, tenacious, conglomerate some gold is liable to be carried away because of the imperfect disintegration of the gravel; also the presence of pipe-clay increases the gold loss. Where such gravel

*No quicksilver is added in the cuts.

occurs it is desirable to disintegrate the gravel by blasting and by introducing, where practicable, numerous drops along the line of sluices. A long line of sluices with frequent drops and many undercurrents reduces correspondingly the gold loss. Of course, an appreciable amount of gold must inevitably escape as flour gold, rusty gold, and amalgam. Properly constructed undercurrents will diminish this loss, but still the last undercurrent of a series of many distributed over a long line of sluices (many miles in length) would undoubtedly catch some gold.

Other conditions not preventing, the length of the sluice system adopted is determined by the cost of the construction and of the maintenance compared with the value of the gold saved by reason of the increased length of the system.

No attempt has been made to introduce a system such as is employed in our best gold mills (see article on Gold Mills, Report State Mineralogist, 1888), to sample the tailings, and, therefore, it is difficult to approximate the percentage loss in hydraulicking operations. The examinations of many "tailings cañons," into which the debris from the gravel mines was washed, lead me to believe that but a small percentage of the gold is lost. It is often asserted that not more than one half of the gold in the gravel bank is saved by this method of mining. In the opinion of the writer, in most well conducted dydraulic and drift mining operations, at least 85 per cent and in many cases upwards of 95 per cent of the gold tenure of the gravel is saved. Mr. Louis Glass, formerly the manager of the Spring Valley Mines, is of the opinion that not more than five per cent of the gold passed off in the tailings.

TAILINGS.

By far the greater portion of the material washed from the banks finds lodgment within a short distance of the tailings' dump of the mine. Fortunately the cañons into which most of the mines tail (*i. e.*, wash the debris) are of no value for purposes other than to serve as storage reservoirs for the mining debris. A properly constructed brush or log dam, preferably the former, for which most of the cañons below the mines afford advantageous sites, would, undoubtedly, impound nearly all the material which at present may be carried to the subjacent farming lands. Coöperative action in this matter, by companies having a common outlet for their tailings, would, in many localities, make it possible to operate their mines without damage to the agricultural or other interests. As these impounding dams become filled by the accumulated debris, they must be raised higher, or, if necessary, other dams must be constructed. But an insignificant amount of material would be carried over the dams as "slickens," in suspension into the valleys into which the cañons debouch. The cost of the construction and maintenance of a system of dams and of the canals for disposing of the "slickens" would be of no moment, as compared with the beneficial result of hydraulic mining.

EXTENT OF CLAIMS.

On account of the great expense usually attending the opening up of drift and hydraulic properties, and the low grade of the material to be mined, enterprises should be conducted upon a large scale. The larger drift or hydraulic mining companies own or control from one to five miles upon

NOTE.—A bar of bullion from the North Bloomfield mine weighed five hundred and ten *pounds* and was worth $114,290. This is the largest gold bar ever cast in this country.

BRUSH DAM, NORTH BLOOMFIELD COMPANY,

LOG DAM

the supposed course of the channel. Some have invested in the property and plant from $1,000,000 to $3,000,000.

LABOR AT MINE.

The larger drift and hydraulic mines work from seventy-five to one hundred and twenty-five men, with wages ranging from $2 to $3 50 per day.

YIELD OF GRAVEL AT HYDRAULIC MINES.

The value of gravel washed at hydraulic mines is estimated usually upon the basis of yield per cubic yard, per miner's inch of water used, or sometimes by the product per acre. A cubic yard of gravel is from one and one half to one and three fourths tons.

Resume of work done by the La Grange Company on all its claims, June 1, 1874, to September 30, 1876:

1,533,728 inches (2,159 cubic feet each) washed 2,275,967 cubic yards of gravel, which yielded 12,026.84 ounces. Troy=$231,893.

Disbursements.

	Total.	Per Cubic Yard.	Per Ounce Metal Produced.
Water	$17,307 62	$0.008	$1 43
Labor	82,345 70	.036	6 85
Material	21,788 35	.010	1 81
Official	11,244 94	.006	94
Contingent	3,125 80		26
Taxes	1,130 41		09
Totals	$136,942 82	$0.060	$11 38

Average value of the ounce of metal (gold and silver) produced	$19 29
Average yield per cubic yard of gravel	.1019
Average amount of gravel washed per inch, cubic yards	1.48

NOTE.—The reader is referred to the excellent treatise of Mr. A. J. Bowie, Jr., for additional data.

Yield of Gravel at Important Hydraulic Claims in California according to Verified Reports.

Name of Claim.	Location.	Cubic Yards Washed.	Gross Yield.	Yield per Cubic Yard.	Height of Banks in Feet.	Report of—	Remarks.
American Co.	Sebastopol, Nevada Co.	5,171,834	$1,241,240 30	$0 24	120	H. Smith, Jr.	
No. 8—1870–74	North Bloomfield, Nevada Co.	3,250,000	94,250 00	2.9	150	H. Smith, Jr.	Paid a profit of $2,232 84.
No. 8—1874–75	North Bloomfield, Nevada Co.	1,858,000	74,271 77	3.9	180	H. C. Perkins	The North Bloomfield produced, from 1867 to 1880, $1,435,680 47; the mining profits were $411,589 27. Hammond.
No. 8—1875–76	North Bloomfield, Nevada Co.	2,919,700	192,735 73	6.6	260	H. C. Perkins	
No. 8—1876–77	North Bloomfield, Nevada Co.	2,293,930	290,775 42	12.7	265	H. C. Perkins	
North Bloomfield	North Bloomfield, Nevada Co.	30,000,000	2,610,000 00	8.7	150–350	H. C. Perkins	
French Corral	French Corral, Nevada Co.	4,200,000	1,745,500 00	41.5	20–100	H. C. Perkins	The greater part of the top gravel had been removed previously.
Manzanita	Sweetland, Nevada Co.	5,780,000	1,489,000 00	26	50–150	H. C. Perkins	About one third of the top gravel had been removed previously.
McCarty's	Columbia Hill, Nevada Co.	3,000,000	345,663 10	4.3		J. D. Hague	
Sicard	Patricksville, Stanislaus Co.	155,347	20,197 07	13	38	J. Messerer	Top gravel.
Delaney	Patricksville, Stanislaus Co.					J. L. Jernegan	
Chesnau	Patricksville, Stanislaus Co.	27,250	11,009 00	40.4	18	A. J. Bowie, Jr.	
Chesnau	Patricksville, Stanislaus Co.	71,810	9,847 48	13	55	J. Messerer	
Chesnau	Patricksville, Stanislaus Co.	284,932	47,781 73	16	12–62	J. Messerer	Aggregate of 7 surveys checked by 1 survey, June, '74, to Oct., '76.
Chesnau	Patricksville, Stanislaus Co.	338,880	62,980 37	18.6	60	A. J. Bowie, Jr.	Includes the last.
New Light	Patricksville, Stanislaus Co.	667,347	45,511 81	6.8	35	A. J. Bowie, Jr.	Drifted previously in places.
New Light	Patricksville, Stanislaus Co.	683,244	45,444 65	6.6	24–60	J. Messerer	Aggregate of 5 surveys checked by 2 surveys.
Johnson	Patricksville, Stanislaus Co.	196,632	9,148 27	4.6	30	A. J. Bowie, Jr.	
New	Patricksville, Stanislaus Co.	17,796	773 72	4.3	42	A. J. Bowie, Jr.	
Kelley	La Grange, Stanislaus Co.	88,660	3,406 33	4	85	A. J. Bowie, Jr.	Result obtained from cleaning out a deep hole.
Kelley	La Grange, Stanislaus Co.	351,152	43,153 26	12.3	75	A. J. Bowie, Jr.	
Kelley	La Grange, Stanislaus Co.	701,685	15,770 34	2.2	100	A. J. Bowie, Jr.	Previously drifted; heavy blasting; no profit.
New Kelley	La Grange, Stanislaus Co.	161,032	8,852 31	5.5	40	J. L. Jernegan	Upper bench gravel.
New Kelley	La Grange, Stanislaus Co.	252,614	35,012 33	13.8	65	J. L. Jernegan	Top and bottom gravel.
New Kelley	La Grange, Stanislaus Co.	1,000,000	64,550 27	6.4	40–65	J. L. Jernegan	Includes the two last data.
French Hill	La Grange, Stanislaus Co.	252,614	35,136 72	13.8	45	J. L. Jernegan	Winter of 1876–77.
French Hill	La Grange, Stanislaus Co.	676,968	90,186 19	13.3	*10–48	J. Messerer	Aggregate of 5 surveys checked by 2 surveys, May, '74, to Oct., '76.

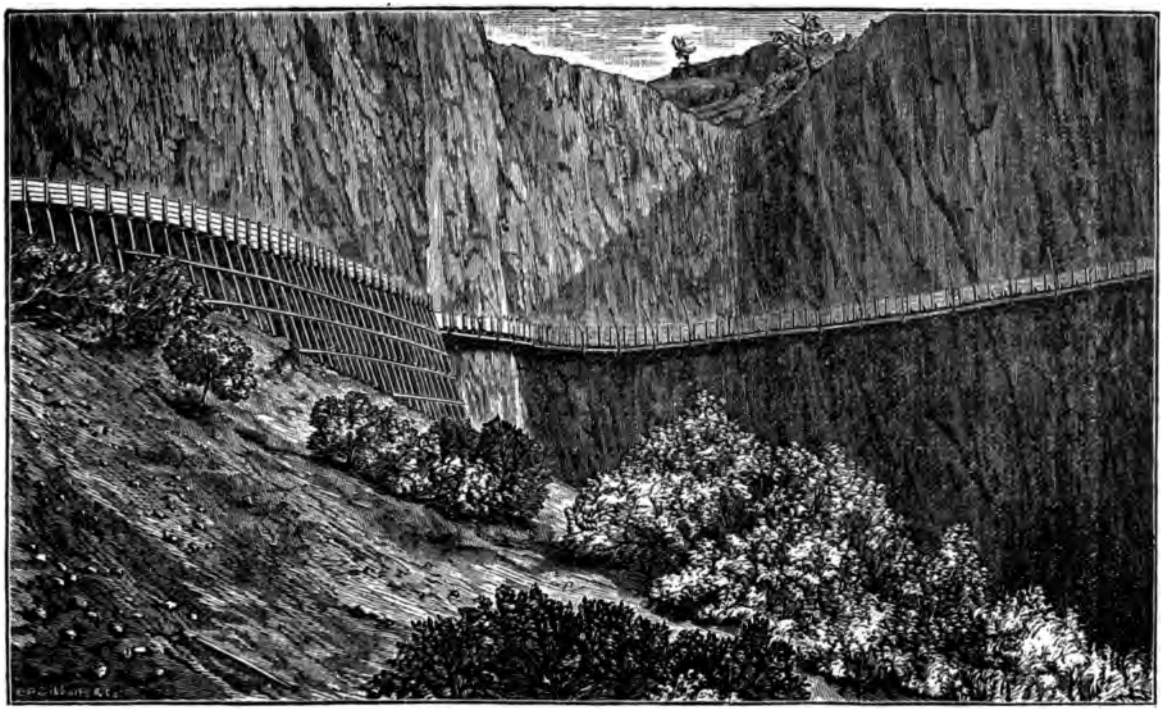
French Hill	La Grange, Stanislaus Co.	1,020,347	188,483 11	15.5	30*	A. J. Bowie, Jr.	Includes the last and also early workings, of which portions had been previously drifted.
Light	La Grange, Stanislaus Co.	746,640	64,714 27	8.6	48	A. J. Bowie, Jr.	Banks contained several thick strata of sand.
Blue Point	Smartsville, Yuba Co.	93,944	115,728 17	1 23	57	H. Smith, Jr.	
Green Flat	Plumas Co.	22,000	15,000 00	67.5	15	A. J. Bowie, Jr.	
Fale's Hill	Plumas Co.	25,000	4,794 49	19	75	A. J. Bowie, Jr.	
Crawford's	El Dorado Co.	77,880	35,046 00	45	85	J. J. Crawford	
Gold Run District	Placer Co.	43,000,000	2,074,356 00	4.8	?	W. H. Pettee	

* Average thirty feet.

Details of Work at No. 8 Claim, North Bloomfield Company.

	1874—1875.			1875—1876.			1876—1877.		
	Total.	Per Cubic Yard.	Per Inch of Water.	Total.	Per Cubic Yard.	Per Inch of Water.	Total.	Per Cubic Yard.	Per Inch of Water.
Cubic yards of gravel moved	1,858,000	....	4.8	2,919,700	....	4.17	2,293,900	....	3.86
Yield	$74,271 77	3.99 cents	19.19 cents	$192,735 73	6.60 cents	27.53 cents	$290,775 42	12.68 cents	48.87 cents
Expenses—Labor	$22,790 39	1.23 cents	5.89 cents	$40,975 85	1.40 cents	5.85 cents	$53,742 78	2.34 cents	9.03 cents
Explosives	2,944 94	0.16 cents	0.76 cents	10,279 73	0.35 cents	1.47 cents	25,376 16	1.11 cents	4.26 cents
Blocks	3,007 26	0.16 cents	0.78 cents	5,212 62	0.18 cents	0.75 cents	5,750 43	0.25 cents	0.97 cents
Material	5,663 89	0.30 cents	1.46 cents	9,250 46	0.32 cents	1.32 cents	10,158 72	0.44 cents	1.71 cents
Water	14,480 40	0.78 cents	3.74 cents	21,740 97	0.75 cents	3.11 cents	21,765 88	0.95 cents	3.66 cents
General	4,201 95	0.23 cents	1.09 cents	7,364 12	0.25 cents	1.05 cents	25,266 11	1.10 cents	4.25 cents
Totals	$53,088 83	2.86 cents	13.72 cents	$94,823 75	3.25 cents	13,55 cents	$142,060 08	6.19 cents	23.88 cents
Days run	295; com. Jan. 1, end. Oct. 14.			342; com. Nov. 13, end. Oct. 18.			318; com. Nov. 26, end. Oct. 13.		
Grade of sluices	6½ inches to 12 feet.			6½ inches to 12 feet.			6½ inches to 12 feet.		
Height of banks	180 feet.			260 feet.			318 feet.		
Inches of water	386,972.			700,000.			595,000.		

MIOCENE COMPANY'S BRACKET FLUME



BRACKET FLUME AND TRESTLE. MIOCENE COMPANY.

SAN DIEGO COUNTY.

Recent Work by W. A. GOODYEAR, Geologist, Assistant in the Field

MONTMORILLONITE, OR "MINERAL SOAP."

Mr. Jackson's house, on the eastern edge of the National Grant, out three miles northeast from the village of Otay, in San Diego , there occurs in the mesa formation a bed of montmorillonite, a s silicate of alumina, containing a far higher percentage of water the case with ordinary clays, the moisture constituting a little over rth its entire weight. It is quite soft, some of it white and some of n color, and has an extremely unctuous or saponaceous feel, which ised it to be locally designated in the region about San Diego by ne of "mineral soap." It appears to form a nearly horizontal bed, from three to four inches to two or three feet in thickness, inter- between the other beds of the mesa at a depth of from forty to et below the general level of the surface. It also appears to be of rable extent, as it is exposed in cañons at two different localities mile apart, and is said to have been pierced at numerous other by wells that have been sunk in the mesa.

eference to the map, it will be seen that the Otay and the Jamul are one and the same stream, the former name applying to its ortion, where it passes through the Otay Grant, while for a similar its upper portion is called Jamul. Following the road up the valley creek, the "mesa formation," consisting of nearly horizontal beds els, sands, and clays, continues to form the whole surface of the for a distance of some ten miles from the village of Otay. But it tops, and for several miles beyond the country consists mainly of olored, very highly metamorphosed, and extremely hard conglom- in which very few traces of their original stratification can now be And, indeed, it is not improbable that some of these rocks may be of igneous eruptive origin.

JAMUL GRANT CEMENT ROCK.

he Jamul Grant a rock has been found from which a good article of lic cement has been manufactured. This rock is an argillaceous ous tufa, and has been deposited here in past ages by mineral , which have long ceased to exist. It has been sufficiently pros- by a number of holes sunk from four to ten feet deep, and irregu- attered over an area a quarter of a mile or more in diameter, to hat its quantity is large. The country rock about here is mostly a rd and tough, dark gray, and sometimes almost black porphyry, of the ground mass, as well as the imbedded crystals, consist of feld-

waters of the hot springs, which must have continued to exist for a ng period subsequent to the eruption of the porphyry, slowly decom- he rock in depth, and afterwards on emerging to the air deposited

most of their lime with a portion of the alumina in the form of this tufa. Numerous bowlders of the still undecomposed porphyry are imbedded in the tufa, and many of them are coated over with a tightly adhering crust of lime, which has been deposited upon them. This porphyry covers a large area of country about here, stretching easterly through the hills on both sides of the Jamul Creek for a distance of some eight or ten miles before the granitic rocks begin to make their appearance.

COTTONWOOD CREEK AND CAMPO.

Beyond this, for a distance of some three or four miles along the road towards Cottonwood Creek, the rocks are extremely varied in character, and mixed in great confusion. Large patches of granite and porphyry occur irregularly scattered about, with other patches of very hard, dark colored, and highly metamorphosed conglomerates and breccias.

The granitoid rocks themselves also vary enormously both in texture and composition, and graduate all the way from a true granite through syenitic granite and syenite to a nearly black rock consisting mainly of hornblende and containing little or none of the constituents of true granite. Many of them contain considerable magnetite in fine grains.

A rock also occurs, consisting almost entirely of quartz and feldspar without appreciable quantities of either mica or hornblende. Most of these rocks are very hard. But some patches were seen of decomposed granite which was red and soft.

Some two or three miles before reaching Cottonwood Creek, however, the porphyries and the metamorphic rocks mostly disappear, and the country becomes almost exclusively granitic.

Bunches and veins of quartz occur here and there which not infrequently contain tourmalines.

Some two miles west of Cottonwood Creek, two different parties were said to be prospecting for gold in the granite, but their claims were not visited.

The country from Cottonwood Creek to Campo is granite, which in at least one locality, just south of Potrero, shows strong indications of having once been stratified, the direction of strike being about north 70 degrees west magnetic, and the dip nearly vertical.

There are said to be some new gold discoveries in the mountains some fifteen or sixteen miles east of Campo.

BUCKMAN'S SPRINGS.

At Buckman's house, some eleven miles northwest from Campo, there are three or four small mineral springs, from which considerable water has been bottled and sold by Mr. Buckman.

The water of these springs strongly resembles that of many of the springs in Lake and Napa Counties. It contains large quantities of free carbonic acid gas, and also a good deal of iron, which, on exposure to the air, is deposited in the form of sesquioxide. One spring produces water which is slightly purgative in its effects, and another one either now is or at some past time has been highly charged with lime, as it is surrounded by a considerable deposit of calcareous tufa.

Continuing northwesterly over the mountains from Buckman's to Pine Valley, the rocks are still granite. But a little beyond the summit there are very large quantities of quartz, which, however, seems to occur here not so much in veins as in irregular, though sometimes very heavy masses.

PINE VALLEY.

Pine Valley, like many others scattered through the mountains, is filled) depths of from ten to fifty feet with récent horizontal beds, through hich the streams have still more recently cut deep channels down in laces to the underlying solid granite. The valley was undoubtedly a ike while the horizontal beds were accumulating, and has since been rained by the stream which formed its outlet, having gradually eroded s channel deeper into the rocks.

PINE VALLEY MINING DISTRICT.

Within the past year some rich gold quartz has been discovered in the iountains a few miles northeast of Pine Valley. There are two groups f claims here, situated about three miles apart, where considerable prosecting has been done. The first, and up to date of visit (viz., late in ctober, 1889), the most promising of these groups is on Section 17, Townhip 15 south, Range 5 east, S. B. M. The other one is on Section 31, ownship 14 south, Range 5 east, S. B. M., and very near the boundary ne of the Cuyamaca Grant. The last of these two groups, called the Deer ark District, was first examined.

Here was found a sort of network of veinules and bunches of quartz running in all directions through a mass of decomposed granite. Most of the einules are quite small, ordinarily not over six or eight inches thick, while one were seen with a thickness of more than two feet. The whole formaon is extremely irregular, and a veinule often, after running a short dis-nce, suddenly stops and gives out altogether in the granite. Small, regular, and isolated bunches of quartz are also common. Much of the iartz of the veinules is more or less distinctly laminated. None of this iartz had yet been worked in either mill or arrastra, and the developents up to that time consisted of a dozen or more small holes sunk at rious points to depths, none of which exceeded twelve or fifteen feet. he only testing of the quartz, so far as learned, had been done with the in and the horn spoon; but estimates thus made ranged from $12 to $20 r ton, and though no single body of quartz of any considerable magnide had been found, yet there was talk of the immediate erection of a tenamp mill; and in favor of this project are the two facts, that wood is enty and that plenty of water can also be easily obtained for such a ill, whether it can be supplied with paying ore or not. The altitude ove the sea cannot be far from four thousand six hundred or four thound seven hundred feet. Some of the white quartz here contains considable tourmaline. Free gold is very rarely visible to the naked eye in e quartz at this locality, though one or two specks were seen.

Outside of this network in the soft granite some work had been done on o or three veins in hard, dark colored rocks in the near vicinity, but othing of importance yet discovered there.

On Section 17 of Township 15 south, Range 5 east, S. B. M., the most omising thing yet discovered was the Eureka Vein, owned by the Noble rothers and their partners. It is situated about four thousand nine huned and fifty feet above the sea, and is a small vein, ranging from two or iree to ten or twelve inches in thickness. It strikes north 40 degrees est magnetic, and dips 78 degrees northeasterly. It was prospected by 1 open cut driven northwesterly some thirty-five or forty feet on the course the vein, the face of the cut at the end being about fifteen feet high. he walls on both sides are soft, decomposed mica-slates, which strike

about north 30 degrees west magnetic, and dip northeasterly at abou same degree as the vein, which latter, therefore, cuts the slates at a sı angle of about 10 degrees. One and one half tons of quartz from this worked in an arrastra, yielded the Noble Brothers $140, and the arra tailings from this same lot still assayed over $50 per ton.

Altogether they had actually taken out of this little cut alone somet over $200, some of which was very rich specimen rock. A thin lay the slate itself adjoining the footwall is also often rich in free gold.

At a point in the cañon, one half or five eighths of a mile south 40 de east magnetic from the mine, and some eight hundred feet below it Noble Brothers had just about got a two-stamp mill, to be run by w power, completed, ready to start up about November 1, 1889. The brothers were doing most of their manual labor themselves; and the ent writer is well pleased to note their prudence, and to remark that, i opinion, their prospects, by beginning thus in a small way, with suc outfit, and such a vein, were very good. From this open cut on the Eu Vein, the South Cuyamaca Peak (the highest one) bears north 68 de west magnetic, and Emery's place in Pine Valley bears south 25 de west magnetic.

About a quarter of a mile south 70 degrees east magnetic from the of the Noble Brothers is the Mollie G Claim, on a vein of quartz in de posed mica slate. It strikes about north 10 degrees east magnetic, near the surface dips about 10 degrees easterly. A slope had been sixty-five feet on the vein in a direction south 50 degrees east magı and at the bottom of this slope the dip had increased to about 35 deg The vein ranged from one to four feet in thickness.

It is said that all of it prospects more or less in free gold, and th assay has yielded as high as $30 per ton. Two or three hundred northeasterly from here, a shaft has been sunk twenty feet on the vein, where the quartz is about three feet thick, and prospects fairly The altitude of the mouth of the slope by aneroid barometer is about thousand four hundred and fifty feet. Some five or six hundred feet netic east from this slope of the Mollie G, and perhaps one hundred higher up the mountain is the Wilcox Claim, said to be on a vei quartz from four to five feet thick, which strikes northeasterly and st nearly vertical in mica slate. Very little work had been done, how on this claim; not enough to show what the vein really is. It is sai have assayed $64 per ton, but Thomas Noble thinks it will average bet $12 and $15.

Some five hundred feet northerly from the mouth of the Mollie G s and on the north side of the cañon, two or three short tunnels, fifte twenty feet long, had been driven on the Acme Claim, where three and nearly parallel veins, from one to two feet thick, strike northwes and dip about 45 degrees northeast.

These veins are also in the soft, decomposed mica slates, the strat tion of which they intersect at angles of 30 degrees to 40 degrees, the bearing more to the west of north than the slates. The high peaks a ter of a mile distant to the east and northeast from the Mollie G are granite.

About eleven hundred feet north 56 degrees west magnetic from Eureka Mine, is the Bay View Claim, where a very different class o occurs in a very different kind of country-rock. A vein of quartz one foot thick here strikes northeasterly, and dips steeply to the north The inclosing rock is fine grained, dark colored, heavy bedded, and *tough and hard*. It is most probably metamorphic, though it may pos

be of eruptive origin. Some of the quartz in this vein is very rich in coarse, free gold. But it also carries considerable magnetite, some pyrite, a little galena, and a good deal of mispickel, thus being on the whole a decidedly complex ore, which will require special and peculiar treatment for its thorough beneficiation. None of this ore had yet been worked, but a tunnel had been driven on it some thirty or forty feet.

Along the road from Emery's, in Pine Valley, past Farley's Summit ranch, through the Guatay Valley, and so on up to Stonewall, the country is almost exclusively granitic and syenitic.

STONEWALL MINE.

If the lines of the United States land surveys were extended across the Cuyamaca Grant, the Stonewall Mine would be found to be located just about the center of the east half of Section 4, Township 14 south, Range 4 east, S. B. M. And it is on a small peninsula which projects northwesterly into the Cuyamaca Reservoir from about the middle of its southeastern side. It is also immediately at the northeastern foot of a little hill whose summit is about one hundred feet higher than the mouth of the main shaft. The following bearings were taken at the mine: South Cuyamaca Peak, south 26 degrees west magnetic; Middle Cuyamaca Peak, south 71 degrees west magnetic; North Cuyamaca Peak, north 40 degrees west magnetic. About three quarters of a mile south 10 degrees east magnetic from the mine is a sharp granite peak, which is probably eight hundred feet higher than the mine, called the Stonewall Peak, and is a prominent landmark for many miles around.

On October 30, 1889, the main shaft of the Stonewall Mine was four hundred feet deep. From the bottom of this shaft a level had been driven for some distance in both directions (*i. e.*, northwest and southeast), and some cross-cutting had also been done at various points. On the third level northwest of the shaft a very large body of ore was exposed for a distance of about one hundred and thirty feet along the drift with varying thickness, which in places was seen to be more than twenty feet; and the face of the drift was still in a very heavy body of quartz. Between the third and second levels the whole of this mass of ore remained almost solid in the mine, very little of it having yet been stoped.

But on the second level it is not so extensive nor so large as it is on the third level. From a portion of this same body of quartz taken from above the second level, they once made a run of $26,000 in one month, being the best single month's run ever yet made with the present ten-stamp mill.

They are now building a new twenty-stamp steam mill, which they expect to have completed and ready to start up about the first of January, 1890. The Superintendent, Mr. Waldo S. Waterman, stated that he then had about one thousand tons of ore already broken and lying loose in the mine, and that the total quantity of ore then in sight would be sufficient to keep all thirty stamps running steadily for at least a year, even if no more should be discovered within that time.

GOLD KING AND GOLD QUEEN.

At the Gold King and Gold Queen Claims, short notices of which may be found on pages 513 and 520 of the eighth annual report, some further work has been done. A slope has been sunk on the Gold King, with a pitch of 65 degrees in a direction north 68 degrees east magnetic, to a depth of eighty or eighty-five feet. And on the Gold Queen a vertical shaft has

been sunk about sixty feet. The vein at the bottom of the Gold King is said to be from twelve to eighteen inches thick. No drifting has yet been done in either mine. But Messrs. Feeler & Melrose, the owners, state that one lot of about fifteen tons of quartz, which they had crushed at the Ready Relief Mine, at Banner, yielded them a little over $100 per ton, and that altogether, up to November 1, 1889, they have taken out about $1,90(from the quartz obtained in sinking these two little holes.

IRON ORE.

Half or three quarters of a mile north of the Gold King Mine, is a bel of country said to be several miles in length in a northwesterly and south easterly direction, over which have been found scattered bowlders and frag ments of iron ore, some of which are rich enough to be of value in country where it would pay to smelt iron. But nothing has been don towards its development here. Also, at a point near where the road com ing from the Gold King Mine meets the road going towards Julian, a smal quantity of copper ore has been found, but not sufficient hitherto to prov of any value.

Samples of iron ore were also obtained from a vein of hematite, said t be twelve to fifteen feet thick, situated in Eagle Peak Cañon near th corner between Sections 34 and 35 of Township 13 south, Range 2 east, an Sections 2 and 3 of Township 14 south, Range 2 east, S. B. M. Mr. Arthu Juch, of Julian, is the owner of the claim on this vein.

JULIAN DISTRICT.

The statement on page 520 of the eighth annual report, line five fror the top, that between Julian and Banner a broad belt of granite intervene is an error into which the writer was led by the fact that the wagon roa over which he traveled from Julian to Banner, following the cañons an being very crooked, goes outside of the slate belt and passes for severa miles over the granite country northeast of it. But as a matter of fact the slate belt itself is continuous, not only all the way from Julian to Bar ner, but also for five or six miles at least southeasterly from the latte place.

Work has been lately resumed in quite a number of the mines in th immediate vicinity of Julian and some very rich ore has been discovered and altogether, at the present writing (November, 1889), it certainly look as if the district were on the eve of another and very successful career c development.

OWENS MINE.

At the Owens Mine, which had stood idle for many years, the ten-stam mill has been repaired and put in good order, and the old vertical shaf which had formerly been sunk to the depth of three hundred feet, ha been pumped out, and retimbered, and sunk fifty feet deeper. No driftin had yet been done when the mine was visited on November first, but a indications, so far as they went, looked favorable. At this mine the were two separate veins, known as the Owens Ledge and the Red Ledg The latter lies a little to the northeast of the former, and near the surfac of the ground they were about twenty feet apart. The strike is abo north 70 degrees west magnetic, and the dip some 80 degrees to the nort east. The Red Ledge has only been worked down to the two hundred-fo level, but the Owens Ledge was worked down to the three hundred-fo

level for a distance of probably between three hundred and four hundred feet along its strike, most of this distance being southeasterly from the shaft. Both ledges are said to have averaged about thirty inches in thickness.

James Kelly, who first worked this mine, and went down three hundred feet, is said to have stopped work about 1873. The mine then lay idle until 1884, when the Owens Consolidated Company took hold of it, discovered the Red Ledge, and worked on that alone until August, 1887, when they stopped, and the mine was idle again until the present year. The mine makes some water, but its quantity is not great. The wall rocks are a fine grained, dark blue, micaceous and argillaceous slate, containing considerable pyrites, and strongly resembling the rocks which accompany some of the richest mines in the more northern counties of the State. The total yield of this mine in the past is estimated by those most familiar with its history to have been something over $300,000.

WASHINGTON MINE.

The Washington Mine, which corners on the Owens towards the southeast, was the first mine discovered at Julian, on the twenty-second of February, 1870. A tunnel was driven some distance northwesterly into the hill, and some very rich rock taken out. Two little shafts, about seventy-five feet apart, were then sunk to a depth of about seventy feet, and the ground between them worked out. This was the extent of the workings in this mine. The vein was small, ranging from two inches to two feet thick, but in places very rich. The rock in the bottom is said to be very hard, and there also they struck some water, which the owners, being poor, were unable to handle, and so were compelled to stop. Mr. Dilks is now reopening this mine, and had just about got the water out of it to the bottom of the old works on November first.

CHIEFTAIN MINE.

The Chieftain Mine lies a little northeast of the Owens. Here a tunnel has been driven about one hundred feet south magnetic to a small vein, which is said to pay from $15 to $85 per ton. A lower tunnel has also been driven here one hundred and eighty-four feet towards the vein, which it still lacks seventy-five or eighty feet of reaching. Work was progressing here when the mine was visited.

The Eagle Mine adjoins the Washington and Chieftain towards the east, but nothing was being done there.

HELVETIA MINE.

The Helvetia Mine, located, perhaps, one mile easterly from Julian, is one of the old and noted mines of this district. It also had been idle for a number of years, but has recently changed hands, and is now being reopened.

At the mouth of the mine very thin-bedded argillaceous shales strike north 75 degrees west magnetic, and dip 70 degrees northeast. A tunnel driven in here, southeasterly on the strike of the slates, encounters the old workings at a point two hundred and ten feet from its mouth, and about seventy-five feet below the surface. There are bunches and small stringers of quartz almost the whole length of this tunnel; but the stringers are not continuous. They range from an inch or less to eight or ten inches thick.

Now and then they suddenly run out entirely, while other stringers now and then as suddenly make their appearance on one side or the other of them in the slates. Two or three isolated bunches of quartz were seen that were five or six feet thick. But these larger bunches are said to be often comparatively poor ore, running from $12 to $15 per ton, while some of the narrow stringers are very rich, often running $75 or more per ton.

The old works are said to have been three hundred and ten feet deep below the surface of the hill, and at the bottom to have extended about four hundred feet along the vein, which was there from two to five feet wide, and averaged $18 per ton. At the mouth of the tunnel a new shaft has been sunk about one hundred feet, with a streak of quartz all the way down which averages about ten inches thick, and runs about $20 per ton. They struck water in this shaft at about eighty feet, but the quantity as yet is small. In the tunnel the slates are generally soft, and can be worked with the pick alone. But in the shaft they have some very hard and tough though still thin-bedded rock.

From here the San Diego Mine bears about north 70 degrees west magnetic, distant perhaps half a mile, and the Owens Mine bears north 38 degrees west magnetic. The Helvetia Mine is said to have produced in the past about $480,000.

SAN DIEGO MINE.

The San Diego Mine was not entered by the writer, but work was also progressing there, and a shaft had been sunk, said to be then one hundred and forty feet deep, with a vein of quartz ranging from almost nothing up to five feet in thickness, and averaging about $15 per ton.

BIG BLUE CLAIM.

On the Big Blue Claim, the owner, Mr. Robert Gardiner, had driven a tunnel south 20 degrees west magnetic, about one hundred and forty feet into the hill, and among the last days of October, 1889, had struck at its face a bunch of quartz not yet sufficiently opened to show its form or size, but which can already be seen to be not less than two feet thick at this particular point, much of it being extremely rich specimen rock which would yield thousands of dollars per ton in coarse, free gold.

FRACTION CLAIM.

About one quarter of a mile northwest of the Ready Relief Mine, at Banner, is the so called Fraction Mine. Here a tunnel follows a small vein three hundred and twenty-two feet northwesterly into the hill. The vein runs from one inch or less to two feet or more in thickness, the pay streak averaging about fourteen inches thick. About sixty feet northeast of this vein there is another one which is about two and one half feet thick. A shaft has there been sunk to a depth of sixty-five feet below the tunnel, and considerable ore stoped out down to that depth. The vein in the bottom of the shaft is about twenty inches thick. This is on the so called Knelly or southwest vein. Northeast of this lies the Cable Vein. The poorest crushing yet worked from the Fraction Mine is said to have yielded $40 per ton, while its general average has been something over $100 per ton. About four hundred feet southeasterly from the Fraction Mine, and on the Cable Vein, a shaft was once sunk eighty feet, with the vein in the bottom of it from three to four feet thick, the quartz running from $65 to $150 per ton. For some distance to the southeast of this shaft the ground

'orked out down to the level of the bottom of the shaft. But northwest no work of any importance has yet been done below the mouth of the shaft.

HIDDEN TREASURE MINE.

len Treasure Mine is supposed to be on the same vein as the ef, and here the vein varies from a few inches to five feet or ickness, averaging probably about fourteen inches, while the id to have yielded an average of about $65 in free gold per ton.

GOLDEN CHARIOT MINE.

Golden Chariot Mine, some two or three miles southeast from l in the same belt of slates, is said to have yielded in the past e of between $600,000 and $700,000. But it has been idle for now. Various stories are current concerning the cause of its One of them asserts that they "lost the vein," inasmuch as they lt" through which they could not find their way. Other stories reditable to the managers. It is said to be about thirteen years stopped work.

of slates from Julian to Banner, and farther southeast, will out one mile in width. Its width, however, varies at different it is not straight, but curved, being convex towards the north-ulian the general strike is north 70 degrees west, but at the ef Mine at Banner it is about north 50 degrees west magnetic. nce of some two or three miles along this belt there are four d veins, known respectively as the Chariot, the Ready Relief, and the Ruby Veins. Of these, the first is the most northeast-ne distances between them are respectively nine hundred feet, l feet, and four hundred and twenty-five feet. All four of these been located continuously all the way from Julian to Banner. incinnati Bell Mine there are two shafts—one eighty feet deep ole Vein, and the other sixty feet deep on what is called the n. The first vein here ranges from a few inches to two feet or ckness, and the other one averages about eighteen inches. The n here has furnished some enormously rich specimen ores, but of drifting that has been done is very small.

READY RELIEF MINE.

at the present time a very large amount of ore in sight in the ef Mine at Banner—estimated by the manager and part owner, Bailey, at twenty-five thousand tons. Mr. Bailey also states iole mass of this ore taken indiscriminately from the mine will erage of $12 50 per ton, free gold in the mill, while portions of urse far richer. He furthermore says that he once ran a lot of the waste heap through the mill and got $6 per ton in free gold These slates contain many small bunches and threads of quartz. e proposes at some future time to run pretty much all his waste igh the mill. The total yield of the mine up to the present een just about $450,000.

g to an estimate published in the Julian "Sentinel," of August total aggregate yield of all the mines of the district, including Chariot and the Stonewall, has been something over $5,000,000,

which certainly speaks remarkably well for this portion of San Diego County.

SAN FELIPE VALLEY.

On leaving Banner and going towards the San Felipe Valley, the road quickly passes out of the slates into a granite region, and from here no rock except granite was seen along the road as far as Warner's Ranch.

WARNER'S VALLEY HOT SPRINGS.

In the northern part of Warner's Valley there are some hot sulphur springs, and many other mineral springs are said to occur in various parts of the valley, some of which contain a good deal of iron.

PALOMAR MOUNTAIN.

West of Warner's Valley and north of the San Luis Rey River there rises a high mountain mass known as Palomar Mountain, which was ascended to the summit, and found to be, according to the aneroid barometer, about five thousand eight hundred feet above the sea. The culminating point is one or two miles westerly from the house of George V. Dyche, who has lived here since 1868, on Section 18, Township 10 south, Range 2 east, S. B. M., at a height of about four thousand seven hundred feet above the sea. Palomar Mountain is really a southern spur of the much more extensive range known as Smith's Mountain. It, however, lacks probably not more than two hundred or three hundred feet of being as high as the highest crest of the main range.

The country here, so far as seen, is all granitoid, though varying largely here, as elsewhere, in texture and composition. Feldspathic veins and bunches of quartz are not uncommon, the latter often containing tourmalines.

Asbestus, with fine fibers six inches long, is said to have been found in the mountains northeast of Warner's Valley, and within three miles of the hot sulphur springs. On leaving Warner's Valley at the northwest end, the road to Oak Grove (which, by the way, is a portion of the old stage road from Los Angeles to Fort Yuma) passes for some little distance over a narrow belt of coarse micaceous schists, which strike about north 45 degrees west magnetic, and stand nearly vertical.

TEMECULA CREEK.

Beyond here the country, so far as seen, for a considerable distance is entirely granitic. Indeed, nothing but granite was seen until just before reaching Radec, a little Post Office on Section 19, Township 8 south, Range 1 east, S. B. M. Here again was found a narrow belt of slates striking northwesterly and standing nearly vertical. Some prospecting has also evidently been done about here for gold, but we did not learn that anything of importance had been found.

Below Radec, there are for several miles along the valley of Temecula Creek heavy beds of granitic debris, in the form of sand and gravel, which are often nearly horizontal in their bedding. Where the granite shows in place along the road down this cañon much of it is thoroughly decomposed and soft, but in the higher portions of the adjacent hills most of it is hard enough. Passing on, we traverse the Paula Grant, where there is a *broad valley* containing many acres of rich, arable land that is still abused

s a sheep pasture instead of being put to the far better uses of which it is apable.

Wolf's Ranch is on the Little Temecula Grant, three and one quarter iiles from Temecula Station, on the railroad. The word Temecula is robably of Indian origin, but its signification was not learned. The word emescal is said to mean, among the rapidly disappearing Indians of this art of the State, a hut built of brush and covered over with earth.

At Temecula Station there was lying (November 10, 1889) a considera-e quantity of dressed street paving blocks of a moderately coarse-grained, ght-gray granite, which is stained more or less yellowish in places by cide of iron.

The rock seems to be hard and durable, and splits and dresses well. It as been used for paving-blocks in Los Angeles and San Diego, and for reet curbing in both those cities, and also in San Francisco. The quarry om which it comes is situated in the foothills on the southwest edge of ie valley, about half a mile southeasterly from the head of Temecula añon. And here it may be well to correct an error which occurs on page 74 of the seventh annual report, lines five to eight from bottom of page, here it is stated that Elsinore Lake, in times of heavy rains, "discharges s surplus waters into Temecula Cañon, a branch of Temescal Creek, which ins to the Santa Ana River." The writer was led into his mistake about ie name of the creek by an erroneous map on which the upper part of emescal Creek is labeled "Temecula Cañon."

As a matter of fact, the only discharge of Elsinore Lake (and this at ire intervals) is into Temescal Creek. And there is but one Temecula reek, which, coming from the higher regions to the east, passes through ie Paula Grant and enters the cañon, followed by the railroad a little low Temecula Station. But, as in other cases, so here; different parts of ie same stream have different names. And for a number of miles south-esterly from its head, and through all the rougher mountains, this cañon, hich the railroad follows, is known as Temecula Cañon. But lower down ong its course, through the Rancho Santa Margarita y Las Flores, the me stream is called the Santa Margarita Creek.

TEMECULA CAÑON GRANITE.

In the Temecula Cañon itself there are now two quarries, one about two les and the other about three miles below the railroad station. From e lower one of these quarries, a block was lying at Temecula Station on ovember tenth, which will dress into about a thirty-inch cube, of a dark ay and fine-grained syenite without a flaw. This block is to form the sis of a monument of some sort at San Diego. The rock contains a little agnetic iron. But it appears to be very hard and strong, and will prob-ly take a beautiful polish and prove to be very durable.

SMITH'S MOUNTAIN.

Thomas Cook, of Temecula, whose father has for many years owned a nch near the highest summit of Smith's Mountain, says that the mount-n consists almost exclusively of granite, and that he has never observed y slates high up in the range, though there are some scattered here d there along its northeastern foot. He also says that no valuable min-als have ever yet been discovered, so far as he knows, anywhere in nith's Mountain. There is, indeed, a tradition to the effect that a good any years ago, a soldier, straying about, found some very rich gold quartz

somewhere in the range. But immediately after his discovery he was overtaken by one of those dense fogs which sometimes cover these mountains, and lost himself, and after wandering about for two or three days at last got out of the mountains and found his way to Warner's Ranch. But he was never able to again return to the spot where he found the gold. This tradition is only related here because it is such a perfect parallel to many other such traditions scattered up and down about the country, some of which, instead of involving a simple soldier, refer to old Mission fathers, whom also they forgot to name. It is hardly necessary to add that all such traditions as these, while not, perhaps, beyond the limits of possibility, are, nevertheless, wherever unsustained by reliable records, very far beyond any limits of probability, and should be treated like the idle wind which blows "it knows not where it listeth."

The highest point of Smith's Mountain is a rather sharp peak some two or three miles in an air line southwest of Oak Grove, and is not far from the line between Sections 13 and 14, Township 9 south, Range 1 east, S. B. M.

David Warren, of Temecula, who is well acquainted with the country says there has been a good deal of prospecting done in the granite mountains northeasterly from Warner's Ranch, and a little gold found in many places, but nothing that would pay.

COAHUILLA OR KAWEAH.

In the neighborhood of Coahuilla Valley, probably on Township 7 south Ranges 2 and 3 east, S. B. M., there is said to have been considerabl quartz found which would run from $4 to $6 per ton, but no mining of an account has ever yet been done there.

And, by the way, this Coahuilla Valley ought not to be mixed up wit two or three others of the same name scattered about the central and south ern parts of the State. The name Coahuilla, though differently spelled, i beyond a doubt originally the same as Kaweah, and there is to-day no pe ceptible difference between the common pronunciation of the two in South ern California. It is an Indian word, and an attempt at the Spanis spelling of which is Coahuilla, while a corresponding attempt to find som English orthography for it is Kaweah. The word probably has a meanin though the present writer does not know what it is. Anyhow, the name ha become attached to several widely separated localities, mountains, valley and at least one large river in the southern portion of the State, and car should therefore be exercised in discriminating between them.

Within a radius of ten miles around the center of Township 10 south Range 2 west, S. B. M., no mines of any value have ever yet been foun so far as I could learn. There was once an old branch Mission at Pala, o the San Luis Rey River, below the Pauma Grant.

ASBESTUS AND TALC.

Peter Mouren, proprietor of the hotel at Temecula, has samples of asbe tus and talc, which he says came from a point about three miles fro Winchester Station, on the railroad between Perris and San Jacinto, an probably from near the southeast corner of Township 5 south, Range west, S. B. M.

Mr. Andrew Bladen, of Temecula, says that about seventeen mil northeast from Temecula, and some eight miles north from Radec, the is a belt of slates in which there is a quartz vein thirteen feet thick, c

which he has sunk two shafts, one twenty-two and the other forty-seven feet deep, and of which the average of many assays gives $18 per ton, though none of it has yet been milled. He also says that it can be traced and has been located for a distance of four miles or more. It is on the northeast side of a slate belt close to the granite. It strikes northwesterly and dips very steeply, probably 80 degrees or so, to the southwest. There is plenty of wood and water close at hand.

GOOD HOPE MINE.

The Good Hope Mine is about six and a half miles northeasterly from Elsinore, and about five miles southwesterly from Perris. It is a vein of quartz striking about north and south magnetic and dipping 40 degrees to 50 degrees towards the west in the granite. Much of the granite here is more or less syenitic, though it is not all so. Much of it also is greatly decomposed and quite soft, though some of it is extremely hard. The old workings here are now all full of water, the mine having been idle for some years. The greatest depth reached in the old works is said to have been between two hundred and three hundred feet. The property has recently changed hands, and is now being reopened.

Two new slopes were being sunk on the vein, one of which was down about sixty feet when visited, and the other one hundred and sixty feet. No drifting had yet been done from either of these slopes. The vein is very irregular in thickness, sometimes splitting up into very thin stringers, or even running out altogether, and again opening out into lenticular bodies of considerable size, some of which are said to have been over eight feet in thickness. There is a five-stamp steam mill here, built by H. J. Booth & Co., of Marysville, in 1881. Some of the ore is extremely rich. Much of it also is more or less crystalline, and of a readily crumbling texture, so that it is very easily crushed. One or two miles northeast of Elsinore some rocks were seen which have the appearance of basaltic dikes, though the exposures here are very poor.

In the hills northeast of Elsinore there stretches for many miles in a northwest and southeast direction a rather broad belt of very highly metamorphosed rocks, some of which consist of very thin-bedded slates, while others are very heavy-bedded, and blocky in their structure, and very hard. Veins of quartz are occasionally found in these rocks, and they are also broken through here and there by irregular and extensive dikes of porphyry and basalt.

LIMESTONE.

At one locality within this belt, and on about the middle of the south half of Section 28, of Township 5 south, Range 4 west, S. B. M., there is a considerable body of hard, dark blue, compact limestone. Here, two small kilns have been built, and some of the limestone burned, producing, it is said, a very good quality of lime. A company is now being organized for the purpose of manufacturing hydraulic cement by mixing this lime in certain proportions with the clays that occur in such large quantities among the hills northwest of Elsinore.

TERRA COTTA.

At Terra Cotta, close by the coal mine of Messrs. Dolbeer & Hoff, a description of which was given in the seventh annual report, pages 175 and 176, some parties have expended about $22,000 in the erection of works for the manufacture of drain and sewer pipes.

These works were erected at this locality in the expectation of emplo ing the clay from a bank close at hand in the making of pipes, and th the mine would furnish the coal for burning them, as well as for maki steam under the boiler. Both expectations, however, were doomed to d appointment. The clay from this particular bank proved to be by means suitable for pipes, and the coal mine has been abandoned, the b proving at this locality of too poor a quality to pay to work. The co therefore, had to be obtained from the Chaney Mine, and the clay fr another locality nearly two miles away. A large quantity of pipe w manufactured, however, and also some brick; but for some reason or oth a very large stock of the pipe still remains on hand undisposed of, and t works are idle now. It is said, however, that preparations are being ma for starting them up again soon.

CHANEY COAL MINE.

At the Chaney Coal Mine a small bunker has been erected, capable holding from forty to fifty tons of coal, and the mine has latterly be producing at the rate of from five hundred to six hundred tons per mon Most of this coal is consumed for various purposes in the region rou about—within six or eight miles of the mine—but some of it is shipped various points along the railroad, even as far as San Diego.

In Temescal Cañon, near Mr. Stewart's house, and but a very sh distance northerly from the Chaney Mine, there are very heavy dikes porphyry and basalt, and not very far from the same locality some cr tallized calcite has been found, which some people have mistaken for gy sum.

Among the granite hills around the San Jacinto River, for a number miles easterly and northeasterly from Elsinore, more or less gold has be found in many places, and considerable shallow placer mining has be done here and there when water could be had.

CLAY BANK.

The bank which furnished the clay that was actually employed in th sewer pipe manufactory above described, is situated on the south half the northwest quarter of Section 21, Township 5 south, Range 5 we S. B. M.

This bank has been opened up so as to expose a nearly vertical face f a distance of some two hundred or three hundred feet, with a maximu height of about forty feet.

There are here a number of separate beds lying conformably one abo the other and nearly horizontal, though really dipping very gently, perha 4 degrees or 5 degrees, towards the northeast. The face of the bank its looks towards the northwest. The different beds vary largely in color a quality, and only certain ones are used. The lowest one exposed is fro five to seven feet thick, of dark blue clay, containing but a small quanti of very fine sand.

Next above this comes a bed from four to five feet thick, of a light y lowish or buff-colored clay, which has been absurdly miscalled "asbestu by the quarrymen, apparently for no cause except that it contains consi erable quantities of very fine scales of talc nearly white in color. It bea no resemblance whatever to asbestus. Next above it comes a heavy be ranging from four to eight feet or more in thickness, the lower, two thir of which is mottled with rose, pink, buff, and white, while the upper p is mostly of a dark red color.

The three beds above described are the only ones which have yet been used. The beds in the higher portions of the bank overlying these, so far as yet exposed, are mostly too gritty to be used as clay, though a few thin streaks of fine quality of clay occur. A thin streak in the upper edge of the lowest bed is almost black in color, and among the red clays small quantities of beautiful red ocher have been found. They are now hauling clay from this bank in wagons, a distance of some six or seven miles, to the railroad at Esinore Station, and shipping it thence to Los Angeles. Some white quartz sand is also being sent from Elsinore to Los Angeles. Besides the large sewer pipe factory above described at Terra Cotta, which, though idle now and unfortunately located, will probably be running again before long, a small establishment has been erected close by the Chaney Coal Mine for the manufacture of pottery, and some very good pottery has been made there; but the quantity so far is small.

HENDRICKS DISTRICT.

A locality called the Hendricks District was not visited, but is situated about the summit of a high peak in the northeastern front of the Sant Ana Range, which bears north 86 degrees west magnetic, distant some eight or ten miles in an air line from Elsinore, and probably two thousand five hundred feet or more above the level of the town. This district is said to have furnished some very complex ore containing lead, silver, copper, nickel, etc. But a single sample from there presented to the writer, and tested at the Bureau, contained no nickel, but only a little copper.

TABLE OF DISTANCES.

The following is a list of distances from place to place as recorded by he odometer:

an Diego to Otay Village	12.35 miles.
tay Village to Camp No. 1, on Jamul Creek	14.30 miles.
amp No. 1 to Camp No. 2, at Engineer's Springs	
ngineer's Springs to Cottonwood Creek	6.41 miles.
›ttonwood Creek to Potrero	5.06 miles.
›trero to Campo	10.33 miles.
ımpo to Buckman's, about	11.00 miles.
ıckman's to Emery's house in Pine Valley	5.78 miles.
nery's to Noble Brothers' new two-stamp mill	4.10 miles.
nery's to Farley's	2.56 miles.
ırley's to forks of road in Guatay Valley	1.71 miles.
›rks of road in Guatay Valley to Stonewall Mine	11.17 miles.
onewall Mine to Julian	9.89 miles.
.lian to schoolhouse at Banner	5.57 miles.
hoolhouse at Banner to Fred. Grant's in San Felipe Valley	3.98 miles.
'ed. Grant's to Summit	8.17 miles.
ımmit to Warner's store	3.68 miles.
'arner's store to foot of mountain where San Luis Rey River leaves the valley, and the road starts up Palomar Mountain towards Geo. V. Dyche's place	8.15 miles.
oot of Palomar Mountain to Geo. V. Dyche's house	6.33 miles.
oot of Palomar Mountain to Oak Grove	16.12 miles.
ak Grove to Radec	9.50 miles.
.adec to Temecula	16.49 miles.
'emecula to Elsinore	17.08 miles.
:lsinore to Terra Cotta	4.36 miles.
:lsinore to Good Hope	6.55 miles.

LIST OF ALTITUDES.

Following is a list of altitudes above the sea as read directly from the ace of a good aneroid barometer:

Camp No. 1, on Jamul Creek	[illegible]
Engineer's Springs	[illegible]
Cottonwood Creek Crossing	[illegible]
Potrero	2,1
Campo	2,
Buckman's	3,
Emery's house in Pine Valley	3,
Camp and mill of Noble Brothers	4,
Eureka Mine of Noble Brothers	4,
Farley's	4,
Forks of road in Guatay Valley	3,
Stonewall Mine	4,
Julian	4,
Helvetia Mine	4,
Cincinnati Bell Mine	3,
Ready Relief Mine	3,
Fred. Grant's, in San Felipe Valley	2,
Summit between Fred. Grant's and Warner's store	3,
Warner's store	3,
George V. Dyche's house	4,
Highest summit, Palomar Mountain	5,
Foot of Palomar Mountain	2,
Oak Grove	2,
Radec	1,
Temecula Hotel	1,

IRON ORE.

Mr. Benjamin Reinhardt, of Chino, has furnished the following d tion of a very large deposit of iron ore in the eastern part of San County: .

From Walter's Station, on the Southern Pacific Railroad, in the Co Desert, it is about fifty miles in a northeasterly direction to the mo Eagle Cañon, and from thence it is about six miles up the cañon to a very heavy bed of iron ore crosses the cañon in an east and west dir On the west side of the cañon it is exposed continuously for the length of one claim, *i. e.*, fifteen hundred feet, ranging from ten feet t than twenty feet in thickness. Beyond this it also shows at interval considerable distance further, and a second claim has been located The flat in the bottom of the cañon here is one half or three quarte mile wide, and beyond this, on the eastern side of the cañon, the said to be exposed continuously for a distance of five or six miles to the east, and to be also larger here than it is towards the west. An ar of this ore by Mr. McCarthy, of Chino, yielded him 63.7 per cent o with only one per cent of silica, and no sulphur nor phosphorus also found in it a trace of silver, and in various samples from one to three fourths of an ounce of gold per ton. The gold can sometin seen in this ore by the naked eye, but whether it will prove to b enough on the average to make it valuable as an ore of gold remains determined.

SANTA CRUZ ISLAND.

By W. A. Goodyear, Geologist, Assistant in the Field.

Of the four islands, Anacapa, Santa Cruz, Santa Rosa, and San Miguel, which lie south of the Santa Barbara Channel, the largest one, viz.: Santa Cruz, was pretty thoroughly examined by the writer in May, 1889. Before proceeding, however, to give a description of this island it is no more than just to say that several statements concerning these islands, and concerning Santa Cruz in particular, on page 185, Vol. I, of the "Geology of California," published in 1865, are utterly erroneous, and are due, as the context partly shows, first to the fact that neither Professor Whitney nor any of his assistants had yet examined the islands, and secondly to the fact that some very ill-informed person who had been there had mistaken volcanic breccias and conglomerates for ordinary "sandstones." As a matter of fact, there is no "sandstone," properly so called, anywhere near Prisoners' Harbor, and much more than three fourths of the whole area of Santa Cruz Island consists of materials that are volcanic in origin. But also, the history of the island has been a very long one, and its detailed geology and stratigraphy are very complex.

According to a map of the island in the office of the company labeled "Section X of Official Surveys," on a scale of $\frac{1}{20000}$, or about three and one sixth inches to the mile, and copied by W. M. Johnson and Stehman Forney, sub-assistants of the United States Coast and Geodetic Survey, in 1875, the extreme length of the island from east to west, in an air line, is 23.474 miles, and its total area is 58,344.55 acres, or 91.163 square miles. The greatest breadth of the western portion of the island is about seven miles, and that of the eastern portion four miles; while the least breadth, at a point between Prisoners' Harbor and Chinese Harbor, is 1.78 miles.

On this map the island is divided by lines, one mile apart, into one hundred and twelve lots, of which forty-eight are fractional, and contain an aggregate of 17,384.55 acres; while sixty-four are complete, containing six hundred and forty acres each, or an aggregate of forty thousand nine hundred and sixty acres. The lines of the lots run north and south and east and west, true course, like the section lines of the United States land surveys, and their numbering begins at the northwest corner and runs first south across the island, then jumps back to the northern shore and runs thence south across the island again, and so on. The line between lots 71 and 72 runs east and west through the midst of the buildings at the Main or Middle Ranch in the central part of the island, and the corner between lots 71, 72, 76, and 77 is about one thousand two hundred and fifty feet east of the office.

Lot No. 6 contains portions of two lots on the north shore.
Lot No. 33 contains portions of two lots on the south shore.
Lot No. 40 contains portions of two lots on the south shore.
Lot No. 41 contains portions of three lots on the north shore.
Lot No. 54 contains portions of two lots on the south shore.
Lot No. 67 contains portions of two lots on the south shore.
Lot No. 74 contains portions of three lots on the north shore.

Lot No. 99 contains portions of two lots on the south shore.

Lot No. 112 contains portions of two lots at the east end.

The highest peak of the island, two thousand four hundred and seven feet above the sea, is known as the Picacho del Diablo, and is situated just about the center of the northern half of the western portion of the island. The largest stream, called the Cañada del Medio, heads a mile or so to the west of the Picacho del Diablo, and after going southerly for a short distance bends to the east, and follows the latter course for five or six miles through the central portion of the island to the Main or Middle Ranch (Rancho del Medio), where it turns to the north and enters the Cañada del Puerto, which it follows for about three miles, to its mouth at Prisoners' Harbor on the northern shore. The Middle Ranch itself is about two hundred feet above the sea. The island is generally very rough, and large portions of it are covered with the densest chaparral.

The Eastern Ranch is at Scorpion Harbor, which is marked on the charts as the East End Anchorage, and the Western Ranch is at the mouth of the Cañon de Cebada, which is misspelled Cervada on the chart. Some other Spanish names are misspelled on the chart. For instance:

Gannada should be Ganado;

Valdaze should be Valdez;

Posa Anchorage should be Pozo Anchorage;

Cochie Point should be Coche Point; and

Cochies Prietos should be Coches Prietos.

Three other localities along the shore are now known by different names from those by which they are designated on the chart:

Cavern Point is now called Palo Parado;

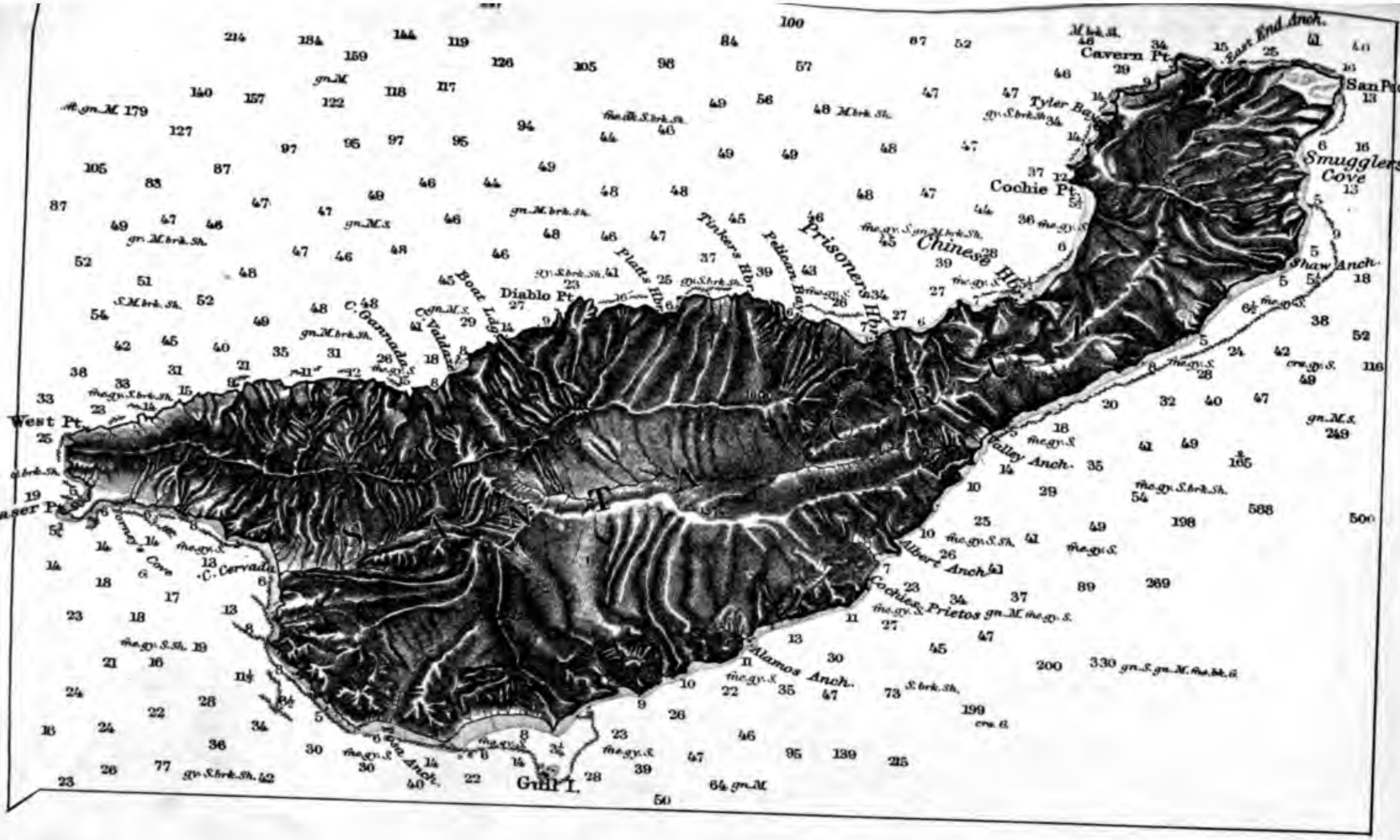
Tyler Bay is now called Potato Harbor; and

Valley Anchorage is now called El Puerto de la Cañada del Sur.

As the island was examined with a good deal of detail, and as its geology proves to be quite complex, it appears to the writer that about as intelligible a way as any in which he can give a description of it will be to first present the details in about the same order as that in which the observations were made in the field, giving successive dates of trips to various localities. In doing so it will, of course, follow that, as several localities were visited two or three times over, facts relating to one and the same locality will, in some instances, be found given in different parts of the report. But with a little attention (which would be necessary in any case) on the part of the reader, that fact need cause no confusion. This course will, therefore, be followed, and after that a few general conclusions may be drawn.

The accompanying map of Santa Cruz Island, will greatly assist the reader in understanding the details of this work. It is a photo-lithographic copy, without enlargement or reduction, from the United States Coast and Geodetic Survey Chart. Its scale is $\frac{1}{200000}$, or 3.156 miles to one inch. The soundings are given in fathoms, except within the dotted areas, where they are given in feet. The altitudes of a number of the higher points on the island above low water are also given in feet.

May 8, 1889.—Left Santa Barbara at 9:20 A. M., and anchored in Scorpion Harbor at the East Ranch at 12:20 P. M. Afterwards took the saddle and traveled fourteen or fifteen miles westerly over very rough hills, some of which are one thousand five hundred feet or more in height, to the Middle Ranch, which we reached about 7:30 P. M. For the first four or five miles of this distance, all the northeastern portion of the island seems to be made up of materials that are exclusively volcanic in origin, being *breccias, conglomerates*, masses of consolidated ash, etc. But the last two


East End Anch.
San Pedro Pt.
Cavern Pt.
Tyler Bay
Smugglers Cove
Cochie Pt.
Shaw Anch.
Chinese Hbr.
Prisoners Hbr.
Pelican Bay
Tinkers Hbr.
Platts Hbr.
Diablo Pt.
Boat Ldg.
C. Valdaz
C. Gannada
West Pt.
Fraser Pt.
Forney's Cove
C. Cervada
Valley Anch.
Albert Anch.
Cochies Prietos
Alamos Anch.
Gull I.
Posa Anch.

ls of the ground passed over by the trail seems to consist chiefly of a ish white clay-rock, which breaks in angular blocks, though the expos- along the trail are few and poor. The wind was very heavy from the ıwest all the afternoon.

ay 10th.—The rock immediately south of the buildings at the Mid- Ranch is a soft, decomposed, reddish-brown porphyry in place, contain- small irregular stringers of quartz. Went to-day with Mr. Jules llet, Superintendent of the island, three miles northeasterly from the lle Ranch, down the Cañada del Puerto to Prisoners' Harbor. The s, all the way down from the ranch to the harbor, are volcanic in origin, pt some deposits of calcareous tufa, which furnish material for lime.

ay 11th.—Went from the Middle Ranch to the Puerto de la Cañada Sur. Everything seen in crossing the island was volcanic.

El Puerto de la Cañada del Sur, the vertical cliffs are from one hun- to two hundred feet or more in height, and consist mainly of heavy ses of volcanic conglomerates, breccias, and tufas, which, however, in y places contain fragments of older shales, amongst which are here there many bits of bituminous shale, showing that the volcanic erup- s are of more recent date than these shales.

ots of pitch or asphaltum are also scattered around over the rocks on beach here, having been washed up by the sea from the south. There metimes calcite among the cementing material of the conglomerates, there are veinules of quartz running through them here and there, h are sometimes faulted. A deposit of calcareous tufa is very close to Puerto de la Cañada del Sur. There are also considerable bunches of ry thinly laminated, hard and tough, impure quartz. The distance the Middle Ranch to the Puerto de la Cañada del Sur is about three s. Mocking birds are quite plenty on the island, and so also is a ll species of fox, which they call the gray fox.

the afternoon went out on the hills to the west of the ranch, and south ie Cañada del Medio. So far as seen to-day, they consist of a sort of -rock, which has been highly metamorphosed, and filled with irregular ıs and veinules of quartz, and then afterwards much decomposed, ing the surface of the hills thickly strewn with small angular frag- ts of quartz. I found in these shales one cube of oxide of iron result- from the decomposition of pyrite. The highest point reached this noon is about one thousand four hundred feet above the sea. From we came down to the Rancho del Portezuelo, and thence followed the se of the Cañada del Medio for several miles back to the Main Ranch. ything seen to the north of the Cañada del Medio was volcanic, so this cañada seems to follow about the line of demarkation between the ınic country on the north, and the sedimentary metamorphic region on outh. Many of the decomposed shales south of the cañada are stained ep red by oxide of iron, while in other places, where they are not so h decomposed, some of them are very hard and very siliceous.

ıe bulb of a small species of wild onion called "cacamite," which s on the island, has a sweetish taste, with a very sticky feeling in the th.

ay 12th.—Went a mile or so up the Cañada del Medio towards the west, crossed over the ridge to the north, and came down to the shore not rom Tinker's Harbor, whence we traveled eastward over extremely h mountain spurs and cañons to Prisoners' Harbor, and then back up Cañada del Puerto to the Main Ranch. Everything yet seen to the h of the Cañada del Medio is volcanic, and mostly in the form of brec- and conglomerates, though among the Pinos Chicos, a little to the

Coche Point being all basaltic. Much of this basalt seems to be massiv although the greater part of it continues to be fragmentary.

At one point in Chinese Harbor the stratified rocks, as seen from Cocl Point, appear to dip, at a rather high angle, to the south; but half a mi further west, where they are well exposed in the bluff, they seem to l nearly horizontal.

The wind has blown very heavily from the northwest for the last thr days, inclusive, its velocity at times in the afternoon reaching probabl fifty miles or more per hour.

May 17th.—We climbed to-day the highest peak of the eastern portic of the island, whose crest is about one thousand seven hundred and fift feet above the sea. This peak is the culminating point of a high and roug basaltic ridge which forms, as it were, the "backbone" of all this part the island. This ridge begins on the northern shore at Coche Point, an runs from thence almost entirely across the island in a direction abo south 60 degrees east magnetic. The highest point is perhaps two thirc the way across the island, southeasterly from Coche Point. About thr quarters of a mile northwesterly from the highest peak there is a Unite States Coast and Geodetic Station, whose altitude is one thousand five hu dred and forty-nine feet. The rock at this station is a coarse-grained basal and all the higher parts of the ridge are basaltic, some of the rock beir massive, though most of it is brecciated.

From the highest point, the stratified rocks in the southern part of tl island immediately southwest from the ridge and southeast from Chine Harbor, look as if their strike were approximately parallel to the course the ridge and their dip southwesterly.

A mile or two southeast from this highest peak the main ridge breal off and descends rather abruptly into some lower hills that skirt tl southern coast. We lunched in a cañon at the Reparo del Aguaje, whic expression does not seem to be good Spanish for the name of a localit but which is used on the island to signify a place by a spring where tl sheep are at certain times gathered together. It is among the lower hil at the southeastern foot of the high main ridge, and only about two hu dred feet above the sea, and there is a spring of water there. At a poi here about fifty feet above the bed of the cañon the white strata, consistir of thin layers of very fine sandstones and hard clay shales, strike abo north 70 degrees west magnetic, and dip about 20 degrees northeast.

At a point in the ridge next west of here they strike about north 25 d grees west magnetic, and dip 25 degrees northeast. In the bottom of tl cañon next west they strike about north magnetic, and dip about 1 degrees east.

The strata in the Cuchilla del Medio and other spurs running o towards the south from the south side of the basaltic masses are general very thin-bedded, and to some extent curve around the basaltic mass lik the coats of an onion. But they are also here and there irregularly curve and bent, and sometimes broken. There is much flint about here. For considerable distance the Cañon de los Paredones Blancos runs abo south 75 degrees east magnetic; and in the next ridge southwest of it, o the northeast side of which the rocks are well exposed for a long distanc they are everywhere extremely thin-bedded, and mostly clay-rocks, an their general strike is approximately parallel with the cañon, and the dip to the southwest at various angles from 15 degrees to 40 degrees. Bu here also, they are in places irregularly bent, and sometimes broken.

May 18th.—The line of demarkation between the high basaltic ridge an *the white rocks* to the southwest of it begins a little west of Coche Poin

and thence follows a somewhat irregular course, whose general direction is not far from south 60 degrees east magnetic, across the island. From here westerly for several miles nearly all the narrow part of the island is white rock. The black basalt, however, shows again at the foot of a bluff just west of Chinese Harbor, and it probably underlies the white rock most of the way in depth.

A great deal of the white rock, even much of the hardest of it, which resembles flint in texture and hardness, emits a strong empyreumatic odor when struck with the hammer, suggesting a strong suspicion that it was once bituminous.

The highest point of the narrow portion of the island lies towards the southern shore, and is about one thousand four hundred and fifty feet above the sea. From it Chinese Harbor bears about north 5 degrees east magnetic, and Prisoners' Harbor north 50 degrees west magnetic. Everything here is the white clay-rock.

In the afternoon, visited once more the Puerto de la Cañada del Sur. Gray volcanic tufas form the bluffs for a certain distance along the central and eastern-central portions of the harbor. Next to them on the southwest, and forming all the hills and bluffs immediately southwest of the harbor, comes the black basaltic breccia in heavy masses. But east of the gray tufa, and forming all the eastern boundary of the harbor, come heavy masses of light yellowish rocks, which undoubtedly belong to the same class as the clay-rocks, which form most of the country for some miles to the east of this Puerto, so that at the Puerto itself the gray tufas occupy the space between the clay-rocks on the east and the volcanic breccias on the west. There is also some calcareous tufa at one or two points here. But while all around the central and eastern portions of the harbor the gray tufas and the clay-rocks form the mass of the cliffs, yet underlying them at near the water's edge, and stretching eastward to the furthest visible cape, the black basaltic breccias are exposed.

May 20th.—Early this morning a dense fog hung over the island. But by 6:30 A. M. this fog had disappeared from the neighborhood of the Middle Ranch, and the sky there was cloudless. Left the Middle Ranch at 6:30 A. M., and at 9 A. M. reached the summit of the Picacho del Diablo, the highest point on the whole island—two thousand four hundred and seven feet above the sea. All the upper part of the Picacho del Diablo, as well as the crests of all the ridges and spurs in this vicinity, consist of heavy masses of volcanic breccia. At 9 A. M., the fog has lifted from all the central portions of the island, but still hangs low and heavy over both the east and west ends. The whole Santa Barbara Channel, and the ocean also to the south and west as far as the eye can see, are one vast smooth level sea of fog, which I estimate to be nowhere more than five or six hundred feet deep, except where it rolls up against some of the flanks of the islands, where it rises in some places at the present moment to heights of one thousand or twelve hundred feet. On the summit of the Picacho del Diablo we are far above it all, and snow-white as the upper surface of the fog is in the sunlight, the sight is very beautiful. The Picacho de los Encinos, the second highest peak on the island—two thousand one hundred and forty-four feet above the sea—bears north 89 degrees west magnetic, about three and one half miles from here, and has every appearance of being made of the same volcanic breccias as the Picacho del Diablo.

None of the peculiar white clay-rock, which forms so much of the narrow part of the island, is visible anywhere from this peak in the western part, and everything north of the Cañada del Medio seems to be dark-colored

basaltic rocks and breccias, which, however, in some places, have been much decomposed.

The "red belt" through the central portion of the western part of the island, and south of the Cañada del Medio, which is probably metamorphic, appears to begin at the west, between the Cañada de Cebada and its northern branch, called the Cañada de los Pinos, and to extend continuously eastward from thence through the island to within a short distance of the Puerto de la Cañada del Sur and the Coches Prietos, being nowhere probably more than one or two miles in width; while to the south of it a broad belt along almost the whole length of this part of the island, and extending quite to the southern shore, appears to be volcanic. This last volcanic belt includes the Sierra Blanca, the highest peak in the western part of the island south of the Cañada del Medio, and also the high chaparral-covered ridge a short distance west of Coches Prietos.

From the Picacho del Diablo we went down the northern slopes of the mountain towards the Cañada de Valdez, and ate lunch at an old Indian camp in the Cañon de las Tasajeras, some three hundred and twenty-five feet above the sea. In the cañon at this old camp, where there is water, one of the banks is a bed several feet in thickness of shells brought here by Indians. These shells are mostly mussels, but there are also a good many very large barnacle shells (some two inches in diameter), and some fish bones. Imbedded in this bank, and almost under the roots of a live-oak tree seventy-two inches in circumference now growing on top of it, I found a human skull, which, unfortunately, however, was too much decayed and too fragile to admit of transportation and preservation.

All the upper portion of the Cañada del Medio itself, down almost to the Rancho del Portezuelo, is in the volcanic rocks.

Mr. Jules Moullet, Superintendent of the island, says that there are a few small patches of "white rock" scattered here and there among the hills to the northwest of the Picacho del Diablo, though I saw none.

May 21st.—In the "red ridge" directly south of the Middle Ranch, the metamorphic rocks are not well exposed; but, so far as can be judged, they appear to strike northwesterly and dip southwesterly, at rather high angles.

The belt of volcanic rocks along the south shore between the Cañada del Sur and the Coches Prietos is perhaps one quarter of a mile wide. But immediately west of Coches Prietos it widens out rapidly, and the breccias in this ridge are generally distinctly stratified. In the hills eight hundred or nine hundred feet above the sea, and half a mile west of the Coches Prietos, they strike about north 50 degrees east magnetic, and dip about 35 degrees southeast. About half a mile still further west in a high bluff a dip of 50 degrees southeast was noticed. All these rocks are volcanic breccias and sands, generally dark colored. On the crest of a ridge some seven hundred and fifty feet above the sea I found imbedded in this breccia some fragments of quartz and also of *talcose slate*. Climbed to the crest of the highest and chaparral-covered ridge to the south of the "red ridge," and found it all volcanic breccia. Afterwards came down to the mouth of the Cañada de los Sauces. All the rocks here are volcanic breccia, and their general dip is to the southeast. They have, however, in places, been disturbed and faulted, and in one place I saw an irregular vein of limestone some six or eight inches thick running up through the face of the bluff for seventy-five feet or more. At one point on the beach here the breccias strike about south 80 degrees east magnetic, and dip some 40 degrees to the south.

May 22d.—At the summit of the trail to the West Ranch (Rancho del ueste) the altitude is not far from one thousand three hundred feet. The ›cks here are all volcanic. The next ridge south of here, which seems to ; a continuation of the "red ridge," is covered with a dense pine forest all rer its northern side, and the cañon next south of here, at the northern foot ' the pine-clad ridge, is called the Cañada de los Pinos. It is a northern :anch of the Cañada de Cebada, which it joins at a point perhaps three ıarters of a mile above the Western Ranch House.

May 23d.—About three quarters of a mile south 33 degrees west from ıe Western Ranch House there is a United States Coast and Geodetic ırvey Station, on the edge of a bluff some three hundred feet or so above ıe sea. The northern portion of this bluff consists chiefly of a heavy mass ' conglomerate, in which the pebbles are rarely larger than a man's head, ıd are mainly volcanic. But a hundred feet further south there rises to ıe top of the bluff a heavy-bedded mass of medium-grained, light yellow ıartz sandstone, the stratification of which could not be well made out om the top of the bluff. In some places this sandstone contains pebbles ' quartz and metamorphic rocks mingled with others of volcanic origin, ıd also with fragments of older shales. At a point a little further south ıd a little lower down in the crest of the bluff, this sandstone is thin-›dded, and its stratification is well shown. It here strikes north 50 degrees est magnetic, and dips 38 degrees southwest. It also here contains :casionally large bowlders of older dark brown, or nearly black sandstone, hich probably is or once was more or less bituminous. Further south ıd on the sea beach, the same sandstone is interstratified with beds of ›nglomerate, the pebbles of which are all small and well water-worn, and nsist of volcanic rocks, with a small sprinkling here and there of quartz ıd metamorphic rocks. The strike here is north 26 degrees west mag-tic, and the dip 35 degrees to the southwest. The bluffs here are all attered with flakes of bitumen. On the top of this sandstone there is o a more recent, unconformable, and generally nearly horizontal deposit volcanic gravel, which is again capped by the shell beds of the Indians xed with the latest soil. Faults of moderate magnitude (*i. e.*, throws of › or three feet) are not uncommon in this sandstone. There is a very tinct odor of petroleum along this beach, and much of the bitumen plas-ed on the rocks has been landed there in a sufficiently semi-liquid con-ion so that it has run a foot or two in little streams down the rocks after ng landed upon them. A quarter of a mile further south there is a con-erable body of very thin-bedded and fragile clay shales, which strike 'th 15 degrees west magnetic, and dip about 50 degrees to the west. ne of these shales are pretty dark-colored, and it is not at all impossi- that they may be slightly bituminous. The upper portion of the bluffs ›und the head of this cove consists generally of more recent horizontal ls of sand and gravel. Along the base of the bluff at the southern remity of this cove there are very heavy masses of conglomerate, the ›bles of which are mostly metamorphic, and some of them granitoid, y few if any volcanic pebbles being mingled with them.

From the top of a high hill a mile or so back from the shore, I took the .owing bearings:

Western Ranch House (invisible), about north 30 degrees west magnetic.
Picacho de los Encinos, north 55 degrees east magnetic.
Center of Sierra Blanca, south 73 degrees east magnetic.
Biggest Gull Island, south 43 degrees east magnetic.
Pozo Harbor, south 13 degrees east magnetic.

This hill is about nine hundred feet above the sea, and though it is covered with soil on the top, it is unmistakably made up of unaltered sandstones, which also, as seen from here, seem to form all the hills along the coast to the south of here and also the hills to the eastward as far as the flanks of the Sierra Blanca (*i. e.*, for a mile or more to the eastward). These sandstones generally strike northwesterly and dip southwesterly at rather high angles. There is a United States Coast and Geodetic Survey Station right here on the top of this hill; but its altitude is not given on the chart. The next cañon south of the Cañada de Cebada is the one at the mouth of which is the cove where the preceding observations on the beach were made, and this cañon is also called the Cañada de los Sauces. It heads on the western flank of the Sierra Blanca. The recent horizontal strata in the bluffs near the mouth of the Cañada de Cebada often show a thickness of fifty feet or more of consolidated sands and gravels. The pebbles here are generally not very well rounded, and to the northwest from the mouth of the cañada most of them are volcanic, though there is also a considerable sprinkling of a variety of metamorphic rocks among them. I could find no fossils of any kind in these horizontal beds. The lower part of the bluff, which makes well out into the ocean a mile or so northwest from the mouth of the cañada, is a coarse volcanic breccia. Immediately south of the mouth of the cañada there is in the bluffs some selenite, which has weathered out in small fragments on the disintegrated slopes.

May 24th.—Went this morning to Pozo Harbor, so called because a well was once sunk to a considerable depth here in the coñon, without, however, finding any good water.

The bluffs immediately at Pozo Harbor are not very high. The lower twenty to thirty feet of them consist of unaltered sandstones and pebbly conglomerates, which strike north 40 degrees to 50 degrees west magnetic, and dip 30 degrees to 40 degrees southwest. Among the pebbles in these conglomerates there is some quartz, and a considerable variety of metamorphic, as well as some granitoid and volcanic rocks. These highly inclined strata are overlaid by from six to thirty or forty feet of recent horizontal beds.

From the United States Coast and Geodetic Survey Station, whose altitude is given on the chart as one thousand three hundred and twenty-nine feet, the highest point of the Sierra Blanca bears south 13 degrees east magnetic, distant perhaps half or three quarters of a mile.

The whole mass of the Sierra Blanca itself and all the white rocks immediately around it, as well as those at the United States Survey Station, are volcanic breccia. The line between these breccias and the unaltered sandstones and conglomerates to the west, passes half or three quarters of a mile west of the survey station and the summit of the Sierra Blanca, and runs, approximately, north 13 degrees west magnetic for several miles, while towards the south its course points almost exactly to the Gull Islands. It is slightly convex towards the west, and continues in about the same general northerly course as far as the Cañada de los Sauces, where it makes a sharp bend to the east and southeast (see below), and passing perhaps one third of a mile north of the United States Survey Station follows a course somewhat to the south of east for a mile or more (*i. e.*, as far as the Cañada de la Laguna), where it again bends somewhat towards the north, and then follows a general easterly course to the Cañada del Sur. Thus the "red ridge" south of the Cañada del Medio gradually widens out in going west, till at a point a little west of the Cañada de la Laguna, and about opposite the head of the Cañada de los

Pinos, it is probably at least a mile and a half in width. Also, in the southern slopes of this portion of it, and about north from the Sierra Blanca, there is considerable granitoid rock in places, but greatly decomposed and soft, and intermixed here and there with strips of highly metamorphic rocks, and perhaps occasionally with volcanic dikes, although this last is doubtful.

Most of the breccias in and about the Sierra Blanca are stratified, and their general dip is southwesterly at rather high angles.

At and for some distance below the bend in the Cañada de los Sauces, the volcanic rocks, instead of stopping at this cañon as stated above, actually cross it and form the whole width of the ridge between it and the Cañada de Cebada for something like a mile to the west of the head of the latter. And for this distance, also, all the rocks visible in the northern slope of the ridge next south of the Cañada de los Sauces seem to be volcanic; while to the north of the Cañada de Cebada, and between it and the Cañada de los Pinos, the rocks as seen from here (*i. e.*, from a point on the crest of the ridge between the Cañada de Cebada and the Cañada de los Sauces, where the pine trees seem to be nearly coterminous towards the west with the volcanic rocks) do not appear to be volcanic, but seem to be a continuation of the "red ridge."

We followed along the crest of this ridge towards the west, and found out that volcanic breccia continues to form a large portion of it, at least as far west as the junction of the Cañada de los Pinos and the Cañada de Cebada.

The crest of the narrow spur immediately southeast of the Western Ranch House is a continuation of the northern part of this ridge, and the summit of this crest at a point, perhaps a quarter of a mile from the house, and about four hundred feet above the sea, consists of thin beds of unaltered sandstone alternating with much heavier beds of beautifully water-worn gravel, many of the pebbles of which are volcanic, the whole striking about north 20 degrees west magnetic and dipping about 35 degrees southwest, the course of the crest itself (which is here very narrow) being about north 75 degrees west magnetic.

May 25th.—Climbed the spur between the Cañada de los Pinos and the Cañada de Cebada. The western end of this spur, for a distance of something like a quarter of a mile from its point, is volcanic breccia. But next come the rocks of the "red ridge," which, where we first strike them, are largely granitoid in character. After following up this ridge for perhaps three quarters of a mile, went down its southern side into the Cañada de Cebaba, and then climbed it again by the cart road somewhat further east. The greatest part of this ridge consists of the "red ridge" rocks, and in this vicinity a great portion of it is syenitic. The "red ridge" rocks probably end towards the west at the point where we first struck them this morning. These rocks, where not granitic or syenitic, are always highly metamorphic, and I have nowhere seen any bowlders or fragments of volcanic rocks inclosed in them. We next descended the north side of the ridge, crossed the Cañada de los Pinos, and climbed the high ridge to the north of it, between the Picacho del Diablo and the Picacho de los Encinos, where everything is volcanic. The summit of the Picacho de los Encinos is a red porphyry. From there we traveled a mile or two further west along the main crest. Everything in this ridge so far, as well as in all the lower country to the north of it, down to the shore, is volcanic, and chiefly breccia. A great portion of the breccias in the higher parts of this ridge appear to be rudely bedded, with a rather high northeasterly dip.

The "horizontal beds," several times noticed above as capping the bluffs along the shores, are not exactly horizontal, but have a very gentle dip towards the sea, about the same in amount as the slopes of the present cañons. And these same beds can be traced far up some of the cañons, sometimes for several miles, and to heights of from six to eight hundred feet above the sea. Though they are often very thin-bedded, they seem to be of subaerial, and not submarine, origin, and they sometimes show evidence of the work of shifting streams.

May 26th.—Close by the Western Ranch House itself the bed of the creek runs over solid volcanic breccia, which contains some fragments of quartz and metamorphic slates, and whose general dip is westerly from 20 degrees to 40 degrees, but which has been more or less locally disturbed and sometimes faulted. There is also considerable quartz in places amongst the interstices of the breccia on the shore to the west of the ranch.

May 27th.—Between the Cañada de Cebada and the extreme end of Fraser's Point there is a strip of lower land sometimes half a mile or more in width, which has a general slope of some 5 degrees or 6 degrees from the foot of the higher mountains towards the south, and ends along the shore in an irregular line of precipitous bluffs, some of which are from two to three hundred feet high. Everything here is volcanic breccia. Hundreds of pelicans roost on the little white islet just off Fraser's Point, and there are a few sea-lions about there. So far as can be seen with the field glass from here, the rocky bluffs wherever exposed on Santa Rosa Island have also every appearance of being made up of similar volcanic materials.

On the top of the bluff, at the West End Point of the island, and somewhere near seven hundred feet above the sea, there is a United States Coast and Geodetic Survey Station, where the rock is a very coarse porphyry, containing crystals of feldspar half an inch or more in diameter. From the foot of the north side of the higher ridge, which forms the "backbone" of this part of the island, for one or two miles easterly from this station a gentle slope extends northerly to the tops of the bluffs, from three hundred to five hundred feet high, which go down almost vertically into the ocean. Everything here is volcanic. The coarse porphyry forms the crest of the ridge for a distance of something like one hundred yards easterly from the station, and then crops out on the southern slope of the ridge for some distance further east. Where it leaves the crest of the ridge it is overlaid first by twelve or fifteen feet of yellowish sandstone, which occasionally contains pebbles and angular fragments of it, the sandstone itself being then overlaid by moderately coarse-grained basaltic rock, the whole appearing to strike about north 20 degrees west magnetic and dip gently to the east. Later in the day the same coarse porphyritic rock was seen on the southern slope of the ridge, about half way from the West End Point to the Cañada de Cebada. For a short distance east from the West End, along the southern slope of the ridge, at an elevation of four hundred or five hundred feet above the sea, there is a line of bluffs which, from some points of view, might be taken for an ancient shore-line "terrace," but it is not one, and neither its base nor its summit ever formed a seashore, for all the mesa below it is breccia and there are no water-worn pebbles there. There are no "terraces" anywhere on the island, and no evidence of any recent rising or sinking; but the bluffs furnish plenty of evidence everywhere that the sea is and for a very long time has been encroaching on the island and wearing it away.

There are no craters, no accumulations of scoria, no lava streams, no columnar forms, no hot springs, no sulphur springs, nor any mineral springs of any kind on the island now. Nor is there any evidence of the

existence of any mineral springs in the past, except of some calcareous ones, which have here and there produced a few deposits of tufa. Everything looks very ancient.

At a point about four miles from the Middle Ranch, on the trail leading to the Eastern Ranch, the white rocks strike about north 50 degrees west magnetic and dip some 35 degrees northeast; and here very fine-grained, somewhat argillaceous, and sometimes rather soft sandstones occur amongst the clay-rocks. The flint and chalcedony often contain vugs of drusy quartz.

On the left bank of the Cañada del Puerto, about one eighth of a mile northerly from the Middle Ranch House, there is a rather heavy body of moderately fine-grained sandstone inclosed in the volcanic breccias, and it is from here that the stone was taken which has been used in facing the corners of one or two of the buildings at that ranch.

Among the birds on the island, besides the mocking birds, there are crows, eagles, gulls, pelicans, larks, bluejays, and humming birds. Linnets are also very plenty in sheltered places. Amongst the insects, flies, both bluebottle and domestic, are very plenty, and are a nuisance. Also the fly which exactly resembles the ordinary house fly, except in its proboscis, with which it bites both men and cattle, is extremely numerous, and is a constant plague to animals. There are some nasty kind of flies, also very plentiful, along the sea beaches. Ladybugs were seen and gnats were encountered on the high peaks of the eastern part of the island. In some parts also there are occasional swarms of grasshoppers, which sometimes do some damage. But not a single mosquito was seen anywhere on the island.

From what precedes it will be evident that the detailed geology of this island is, as already stated, very complex. This examination is very far from being as full as it might have been made with further time and means at disposal, and yet it is full enough so that it will be impossible to understand it without an adequate map. But with the map, and after careful study, a few general conclusions may, with reasonable safety, be drawn:

First, the oldest rocks on the island are beyond question those of the "red ridge," which, lying south of the Cañada del Medio, and stretching westward from near the Cañada del Sur to a point between the Cañada de los Pinos and the Cañada de Cebada, consist chiefly of very highly metamorphosed slates and sandstones, with granitoid and syenitic rocks towards the western end. These rocks are similar in general character, and may belong to the same geologic age, as certain rocks in the mountain ranges on the continent to the north.

Next in order of age on this island probably come the white clay-rocks, which form so large a part of the narrowest portion of the island, as above described, and which contain impressions which suggest fossil leaves, and which very often give out a strong empyreumatic odor on being struck by the hammer, however hard they are. These rocks were probably laid down in deep sea waters long before any volcanic disturbance began. The arguments are these:

They were probably laid down in deep sea waters because they are generally extremely thin-bedded and very fine-grained. They are probably older than the volcanic rocks, first, because they do not inclose any volcanic fragments within them; and second, because they are universally upturned at high angles, and flank the volcanic rocks in various directions.

In fact, all this lot of white clay-rock probably belongs to the Coast Range series of bituminous shales, so largely developed on the continent opposite. In support of this *may be repeated* the fact that so much of this white

clay-rock still emits so strong an empyreumatic odor when struck with the hammer, however hard it may be, and the further fact that a soft bed of unquestionably bituminous shale was found to immediately underlie a bed of this same hard clay-rock at Smuggler's Cove. For the deep sea origin of this rock there is also an argument in the absence of fossil shells; for most shell fish live in shallow depths.

I shall presume, therefore, that this clay-rock was deposited in a deep sea long before the volcanic disturbance began. But that disturbance came at last. Yet its action also extended over a very long time, and most if not all of the volcanic eruptions, properly so called, took place beneath the sea long before the island was lifted above its waves. Otherwise it would be impossible to account for the vast accumulations of stratified breccias, conglomerates, and volcanic sands without craters or scoriæ.

After the actual volcanic eruptions had nearly or quite ceased, but while the whole, or at least the greater part, of the island was still beneath the sea, came the formation of the white and more or less calcareous rocks containing sea shells, patches of which still remain at the Palo Parado and Potato Harbor, and perhaps also at other points in the eastern part of the island. Contemporaneous with these may have been the accumulations of unaltered sandstones and conglomerates containing volcanic pebbles and bowlders, which cover a good many square miles in the southwestern corner of the island, and which are generally upturned at high angles. After this came the final upheaval, which has lifted the island to its present height above the sea, upturning, bending, and crushing, to a greater or less extent, in different places, all the stratified rocks about it. But this upheaval itself was probably a slow and gradual process, occupying a very long period of time.

Then came the slow subaerial denudation and degradation which gradually formed the nearly horizontal beds which cap the bluffs and extend to considerable distances inland up the cañons in certain portions of the islands, as described above.

Last of all came the most recent period of more active erosion which has shaped the cañons as they now are, and has worn, and is still rapidly wearing away the bluffs along the shore.

As to the question whether these islands were ever connected with the continent by dry land which has since been washed away or sunk beneath the sea, every indication points most decidedly to the conclusion that they were never so connected.

First, the essentially volcanic character of the islands is entirely different from anything known to exist on the continent within a great many miles of the coast in this part of the State. Far more than three fourths of the whole area of Santa Cruz Island consists of volcanic materials.

Again, the breadth and depth of Santa Barbara Channel point strongly in the same direction. No point of Santa Cruz Island is less than twenty miles distant from the main shore. And the crooked line of deepest soundings through the channel, which is shallowest north of Anacapa Island, nowhere shows a depth of less than one hundred and seventeen fathoms. North of Santa Cruz Island the minimum of deepest soundings is one hundred and thirty-five fathoms. North of Santa Rosa it is three hundred fathoms, and north of San Miguel it is two hundred and twenty-five fathoms. But south of the islands the bottom slopes off rapidly into the ocean depths, and soundings of five hundred fathoms are found within a few miles from the shores.

It thus appears that these islands extend along the course of an ancient *volcanic rift* bordering the continent. At what period the disturbance

which caused their uplift first began it is difficult to say, except that it seems certain that it was subsequent to the era of the accumulation of the bituminous shales. And at what time the volcanic action ended it is also impossible to say, except that it was certainly many long ages ago.

Wherever altitudes above the sea are given in exact figures in the foregoing notes, they are taken from the United States Coast and Geodetic Survey chart. But wherever they are only approximately given, and wherever the word "about" is used in connection with them, they are simply observations with a good aneroid barometer, which, wherever tested, as was often done at the various United States Coast and Geodetic Survey Stations, was found to agree generally within less than fifty feet with them.

It is not out of place here to say that my kindest acknowledgments and thanks are due to Mr. Justinian Caire, proprietor, and Mr. Jules Moullet, Superintendent of the island, for having freely placed at my disposal every possible means that could assist me in my work.

Since writing the article concerning Santa Cruz Island, I have read with great interest sundry articles in the Proceedings of the California Academy of Sciences concerning the Channel Islands.

Most prominent among these articles are two: First, an article by Prof. E. L. Greene in the Bulletin, Cal. Acad. of Sci., Vol. II, No. 7, June, 1887, page 377; and, second, an article by Prof. Joseph Le Conte in Bulletin, Cal. Acad. of Sci., Vol. II, No. 8, page 515, in which Professor Le Conte reviews Professor Greene's article.

And, in view of all these articles, I will venture to reiterate emphatically my own opinion that there is not, as yet, one particle of evidence tending to show that these islands were ever connected, dry-shod, with the mainland. It is probably true enough that they are situated along the southwestern edge of what might be called the continental plateau, and that just southwest of them the bottom slopes steeply down into the great depths of the Pacific Ocean. But what right has anybody to theorize from that fact alone as to their previous connection with any continents on one side or the other?

Professor Greene suggests, on page 388, that "our little archipelago may actually have been connected with some other continent than ours."

Professor Le Conte maintains, on the contrary, that the islands were once joined to the mainland, and amongst his proofs refers to Proceedings of California Academy of Sciences, Volume V, page 152, as showing that "remains of the mammoth have been found on Santa Rosa."

On reference to Volume V, page 152, I find this paragraph: "Mr. Stearns called attention to the fossil tooth of a species of elephant from Santa Rosa Island presented some time ago by Mr. W. G. Blunt, as it proved that the island was formerly a portion of the mainland. He had been informed by Mr. Blunt that the tooth had been found *in situ*, and near it was embedded the tusk of an elephant, the latter so far decomposed that it crumbled in the attempt to get it out."

This was in 1873. Now, I know Mr. Stearns well, and know him to be an able and upright man, but I also know that he was liable to be sometimes mistaken, especially where he got his information at second hand, as is confessedly the fact in this instance.

I very much doubt the *fact* whether any "elephant" or "mammoth" bones were ever found on Santa Rosa Island. I think it far more likely that they may have been fragments of the bones of a whale or some other marine animal. But, even granting it were true that bones of the mammoth had been found there! What does that prove, or what does it amount

to, in the face of a hundred other conflicting facts which point another way?

The very fact of the vast difference between the flora of these islands and the flora of the mainland, is a strong argument against the supposition that they were ever "connected" with it.

It seems to be necessary every now and then to remind even the most famous geologists of the stale fact that "*geologic time is long.*"

Now, if these islands were uplifted during the miocene epoch (which seems not improbable), time enough has elapsed since then to allow for all the differentiation and modification, or even *evolution* of species of both plants and animals that has occurred.

There is not one particle of evidence to show that they were ever "connected with the mainland."

NOTES ON THE GEOLOGY OF THE CHANNEL ISLANDS.

By Dr. Lorenzo G. Yates, F.G.S.A.

ıg a recent cruise among the islands forming the southern boundary anta Barbara Channel, the writer noted some facts and generaliza- the geology of the islands which, supplementing other notes made a visit to Santa Rosa Island some twelve years ago, are herewith ı being of interest, not only from their peculiarities in a geological view, but, also; as presenting some grand and picturesque scenery, ality which, although but a short distance from some of our well ·esorts, and almost in the immediate track of the great bulk of the ın the coast of Southern California, is still a locality about which known.

ɜands of our people have lived all their lives within fifty miles of lands, passed within a few miles of their picturesque, cavernous ınd know comparatively nothing of them, but the time is not far when they will be considered as among the most attractive objects ɜst on the Pacific Coast.

their peculiar position relative to the adjacent shores of the main- ey act as an immense natural seawall, which not only protects the ɔm the southerly storms of winter, but also affords a safe channel north side for a distance of about one hundred miles from Point ɔion eastward.

ɔhain of islands, composed of San Miguel, Santa Rosa, Santa Cruz, Anacapas, are of volcanic origin, and seem entirely separate and from the formation on the mainland, except that a similar volcanic ɔn seems to extend for some distance on the mainland south of the 'lara Valley.

ɔase and formation of the islands, at and below low water mark, be composed entirely of hard, black amygdaloidal basalt, contain- ʼsolite and chalcedony in the cavities. This formation extends to wenty feet above high water mark, although this height is not

ock of the later formation overlying this base is composed of basalt ıer rocks in various stages of decomposition, and in many places ·d or broken up by upheavals and intrusions.

peculiarity is especially apparent on the islands of Santa Cruz and .capas, where in many places vast quantities of breccia occur.

ıarder fragments in these breccias gradually weather out, and fall- n the debris of the shore, and also that at the bases of the steep ·pendicular cliffs, which are common to the shores and the interior ılands.

\nacapas consist of three separate islands (see map, Figure 1), h the passages are so narrow between them that, unless closely ɜd, they would be supposed to be connected. They, at a compara- ɜcent time, doubtless formed one continuous mass of basalt, but in ence of the presence of veins of softer rock, which are seen at short s crossing or cutting the horizontal layers of basalt, caves are formed

by the combined action of the waves, the wind, and the rain, which in time cut entirely through the deposit and formed channels between the different portions. This characteristic is shown in Figure 2, where the ocean has encroached on the land from both sides, leaving a narrow strip, only a few rods in width, through which the wind and waves have formed a beautiful arched passage, by which one may pass on foot from the channel to the ocean side of the larger or Western Anacapa.

At this point the basaltic rock takes on various forms, as we find a beautiful amygdaloidal basalt, the cavities of which are lined with drusy crystals of chrysolite; vesicular trachyte, some of which is decomposing and contains iron pyrites, the surface having a yellowish powdery appearance. These formations are very pretty under a magnifying glass.

The basaltic rocks at this locality are more interesting than at any other point visited, some of it being coarse grained and dotted with amygdaloidal pebbles of milky white chrysolite, or translucent opal-like chalcedony; others with small and closely set, round, white "shots" of chrysolite or chalcedony, and on the channel side near the archway we found a distinct ledge or vein of pale, pink chalcedonic quartz, which we traced for some distance.

On the top of the archway there seems to be a light deposit of drift, or possibly sea-worn pebbles, carried there by heavy storms before the passage was cut through; or, possibly, the entire island may have been uplifted, and this old sea beach is now perched upon the top of this passage way.

At a short distance eastward there is a channel of about sixteen feet in width, which divides the western from the middle island.

Figure 3 shows the channel between the middle and eastern islands, which can be crossed on foot at extreme low tide.

In Figure 4 we have an illustration of two stages of the effects of the destructive agency of the elements. In the arch on the right we see the opening made by the action of the waves; the upright column between the arched rock and the eastern extremity of the island, shown on the left of the sketch, illustrates a more advanced stage, in which the arch has fallen in, leaving only the upright portions.

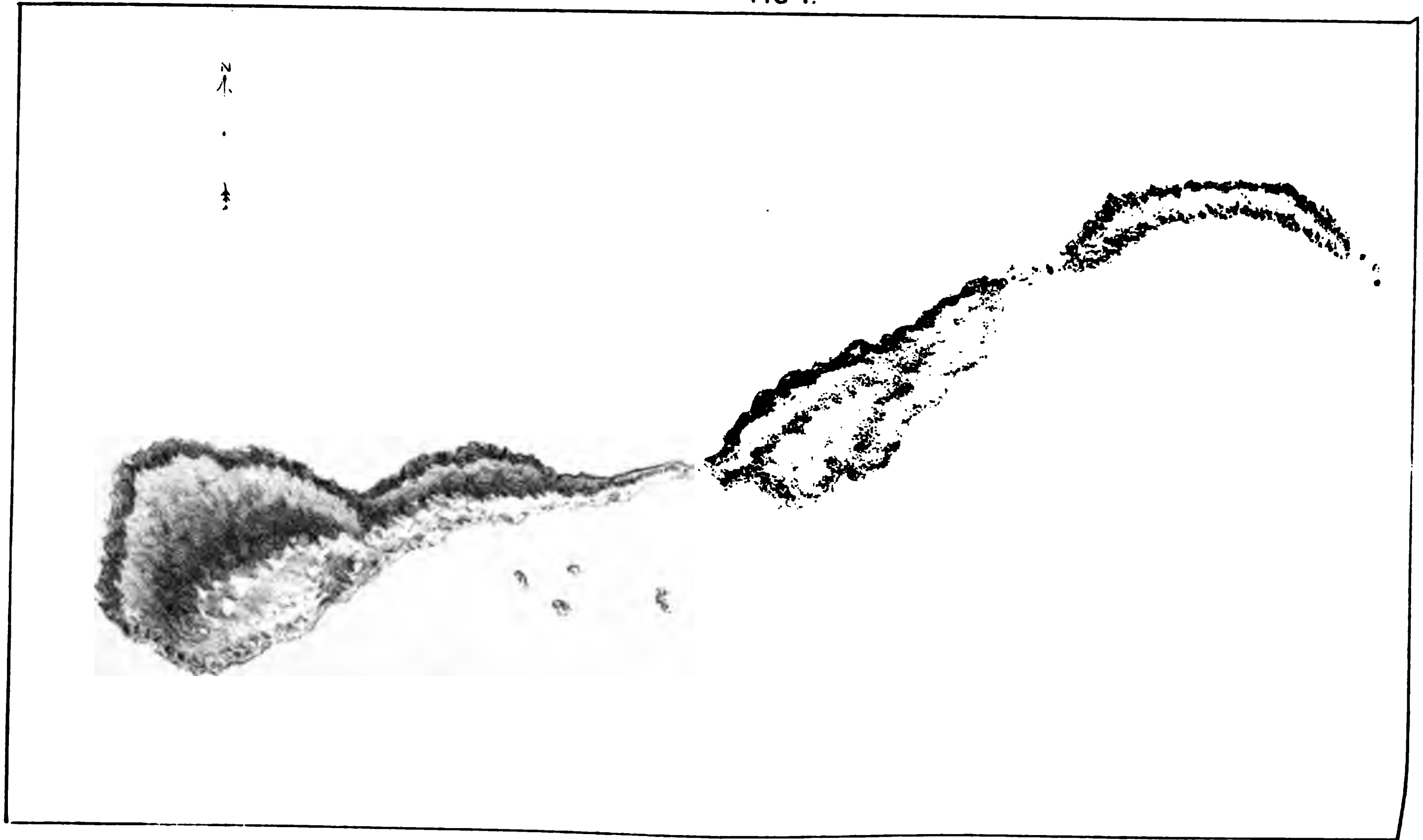
These openings are consequent upon the presence of vertical seams, crossing the islands at irregular intervals. These seams or fissures, probably caused by contraction or upheaval, subject the sides to the action of the exterior elements to a great depth, eventually forming veins of wacke or softened basalt. The beating of the waves and action of the tides on these veins of decomposed rock at the base of the cliffs form caves, which, by confining the incoming waves, are still more rapidly disintegrated than is the rock, which is not so exposed or acted upon.

This action of the waves, supplemented by the action of wind and rain at and below the surface, results eventually in forming chasms, extending from the cave at the base to the upper surface, and entirely across the islands in the narrower places; and, as the islands are continually being encroached upon from both sides, these divisions will increase more rapidly as the islands become narrower, and will become reefs of numerous isolated rocks.

The material of which these islands are composed must have been formed originally by a series of volcanic outbursts.

The only sandstone on the Anacapas is on the Western Island, where it is probable that the high peak, illustrated in Figure 4, may be sandstone. As none of our party climbed to this point, I cannot state positively that *it is* not sandstone; but that it is, is probable from the fact that on the *Island of Santa* Rosa, on which I reported in 1876 (and which report, from

FIG I.



MAP OF THE ANACAPAS

my notes, was published in the Smithsonian report for that year), it will be seen that an extensive sandstone formation overlies the volcanic deposit on Santa Rosa.

In the sandstone of Santa Rosa Island I found several species of fossil shells of a late tertiary age, including *Hinnites giganteus*, *Turritella inezi-ana*, *Neverita callosa*, *Pecten pabloensis*, *Liropecten estrellanus*, *Venus Ken-nerlyi*, and a shell which Dr. J. G. Cooper determined as *Turbinella coestus*.

The report of the United States Coast Survey for 1862 also states that "the main peak of the Anacapas is marked on the north side by several deep gulches, with almost vertical sides running from the summit to the bluff. The whole formation is filled with innumerable cavities, giving it the appearance of an enormous blackened honeycomb." It is also stated that "not a drop of water is to be found on the island." Later researches have, however, demonstrated that good water exists there. One spring trickles from the rocks at the mouth of one of the large number of caves which occur at various places in the cliffs along the shore.

This fresh-water cave has furnished shelter to many generations of aborigines, as is evidenced by the extensive deposit of refuse on the floor, among which are found a large number of bones of various species of fish and cetaceans, mixed with marine shells and other refuse of an Indian rancheria. We learned of another "Indian cave" at the eastern extremity of the Middle Island, but did not visit it.

How many centuries have been required to bring about these great changes is unknown. The ancient lavas remain, to impress upon the mind of the thoughtful observer some idea of the æons of time which must have elapsed since the great changes in the conformation of the earth's surface took place, which have brought about the comparatively simple and unimportant changes which are indicated by the position and formation of these islands.

At one point only on the Middle and Eastern Anacapas did we find any rocks not of volcanic origin. On the table land of Middle Island, on the southern side, we found drift composed of fragments of talcose schist containing garnets, mottled jasper of various colors—red, brown, black, yellow, and green—large pebbles of chalcedony, and near this point a small ledge of impure limestone, with quartz and siliceous pebbles.

The oldest name for the Anacapas of which we have record is that of Innecapah in Vancouver's narrative, and Enecapah of his chart.

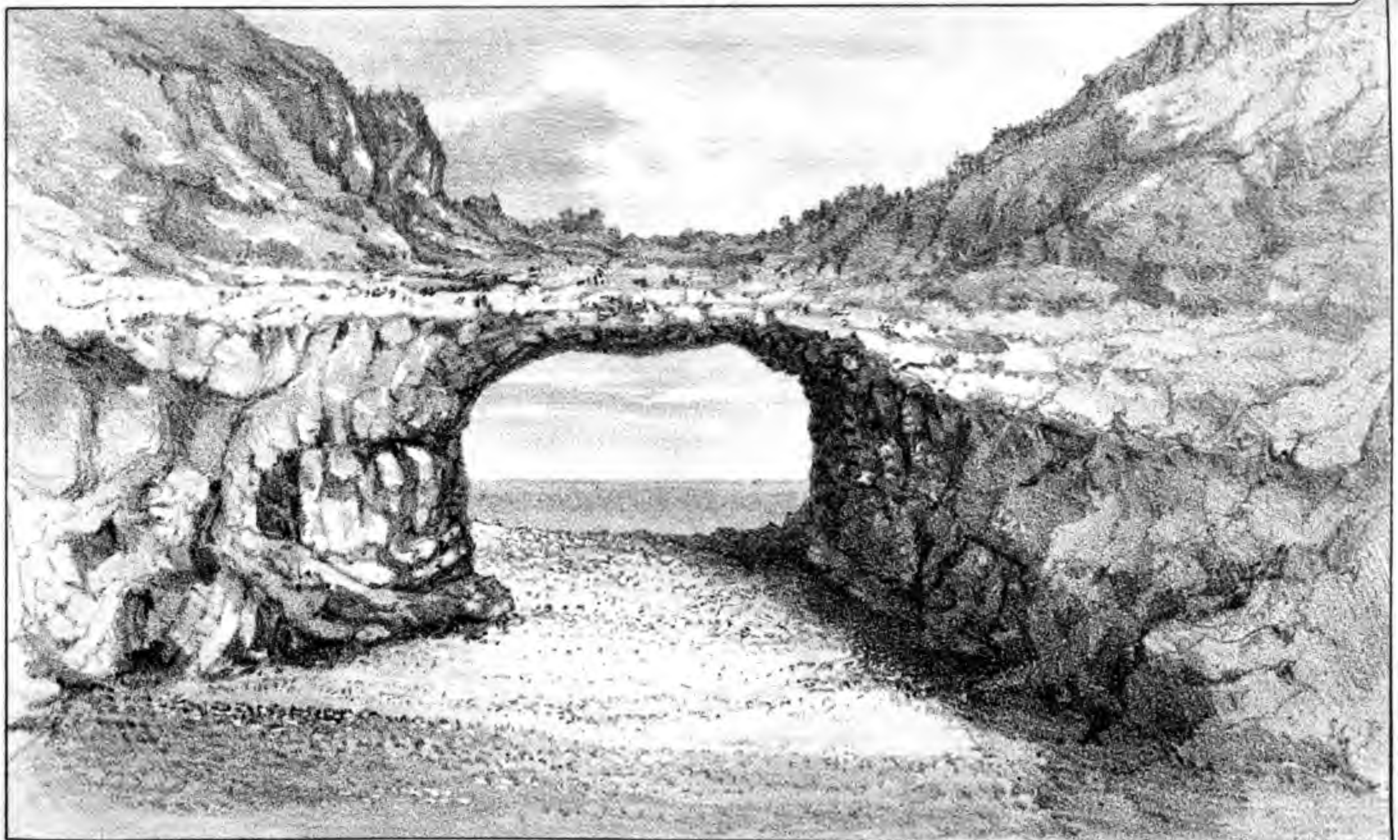
Santa Cruz Island is also put down in the Coast Survey Report as being "composed of coarse, dark gray sandstone, crumbling and rotten, like that of Anacapa." But how a party of scientific men, such as must necessarily be included in a Government coast survey, could report these islands as composed of "dark gray sandstone," when it is almost impossible to land upon the Anacapas without climbing over and among the coarse, black masses of basalt, which no one could for a moment imagine to be dark gray sandstone, is a puzzle.

One very interesting cave is located near Lady Harbor, on Santa Cruz Island, and is weathered out of the hard, rough, black basalt, presenting three entrances or arched openings, into one of which we rowed our boat, landing upon the smooth sandy beach of the sheltered interior, from which point we could pass through the other opening either way along the shore on foot. This cave is quite extensive, and is, perhaps, thirty to forty feet high. We visited a number of these caves, and sailed along close to the shore of all the Anacapas and Santa Cruz, passing miles of perpendicular basaltic cliffs, weathered out into all manner of forms; and the depth

of water close to these cliffs is such that in the main a vessel can pass al within a stone's throw of the bluffs. So closely did we sail that we cc distinguish the small plants clinging to the bluffs, some of them ha\ the appearance of rosettes closely set over the face of the rock.

NOTE.—The map, Figure 1, is not made from any survey or scale, but was made v standing upon an elevated portion on Middle Island, and merely gives the idea as I (prehended it from that point; and in consequence of the interruptions of all commu tion with the outside world, resulting from washed out railroads, and the partial destruc of telegraph lines, the writer had less than a week in which to prepare the articles illustrations.

FIG. 2.



ARCHED PASSAGE NEAR EASTERN END OF WEST ANACAPA (LOOKING NORTH)

THE MOLLUSCA OF THE CHANNEL ISLANDS OF CALIFORNIA.

By Dr. Lorenzo G. Yates, F.L.S.

The so called Channel Islands of California form the southern edge of the Santa Barbara Channel, and represent a peculiar province, in which may be found a greater variety of mollusca than in almost any other region of equal area.

Commencing at the island of San Miguel, off Point Concepcion, we have a coast exposed to the full force of the summer trade winds, which keep that portion of the province under the almost continuous action of the heavy swell from the northwest. This force gradually diminishes as we pass the islands of Santa Rosa and Santa Cruz, until on arriving at the Anacapas, the most easterly of the group, the force of the trade winds is so diminished as to be scarcely noticed. Then, again, the ocean side of these islands is exposed to the full force of the southerly storms of our winter season, while the channel side is protected from all these vicissitudes, and consequently affords convenient and safe habitation to those mollusca which delight in still water.

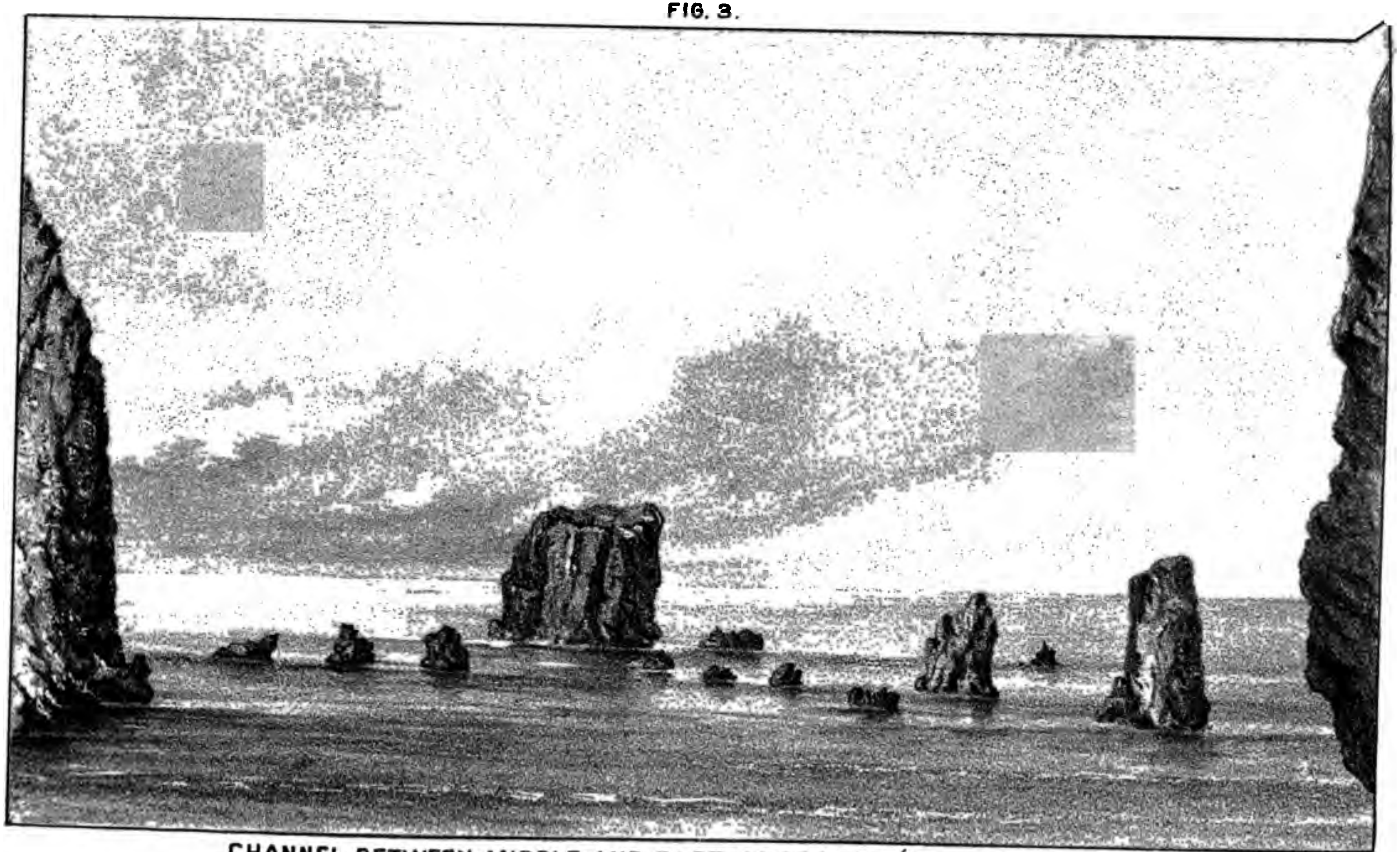
The character of the shore line at different points varies greatly, thus presenting all the varied requisites for the different requirements of the mollusca found on our coast; hence, these islands form a neutral ground, upon which the mollusca of the northern and southern faunas meet, and, as it were, overlap. They are the northern limit of *Luponia spadicea* and many other species, and the southern limit of many other genera and species.

The following list includes the species collected by the writer around the shores of Santa Rosa, Santa Cruz, the West, Middle, and East Anacapas. One species only (*Argonauta argo*) I did not find myself, as it is only at certain times that they are found. The various islands are referred to as follows: R. for Santa Rosa, C. for Santa Cruz, and A. for Anacapas. The list also indicates the species used by the aborigines of the islands, who formerly inhabited them. Those used by the former inhabitants as food are marked †; the species marked * were used for ornaments or money; those marked ‡ were used for paint cups and also as food.

Pholadidea penita, Conr.—R.
Pholadidea ovoidea, Gld.—R., C.
Parapholas californica, Conr.—R.
Saxicava pholadis, L.—R., C.
Glycimeris generosa, Gld.—R.
Cryptomya californica, Conr.—R.
Schizothærus nuttalli, Conr.—R.
Thracia curta, Conr.—R.
Entodesma saxicola, Baird—R.
Mytilimeria nuttalli, Conr.—R.
Solen sicarius, Gld.—R.
Macoma yoldiformis, Cpr.—R.
Macoma nasuta, Conr.—R.
Macoma inquinata, Desh.—R.
Tellina bodegensis, Hds.—R.
Tellina bimaculata, Linn.—A.
Lutricola alta, Conr.—R.
Cumingia californica, Conr.—R., A.

Standella planulata, Conr.—R.
*Tivela crassatelloides, Conr.—R.
Psephis tantilla, Gld.—R.
† Venus simillima, Sby.—R.
† Venus succincta, Val.—R.
† Tapes staminea, Conr.—R.
Tapes staminea, var. orbella, Cpr.—R.
*Saxidomus gracilis, Gld.—R.
Saxidomus nuttalli, Conr.—R.
Rupellaria lamilifera, Conr.—R.
† Petricola carditoides, Conr.—R.
† Chama exogyra, Conr.—R., A.
Chama pellucida, Sby.—R., A.
Chama spinosa, Sby.—R., A.
Cardium corbis, Mart.—R.
† Cardium quadragenarium, Conr.—R.
Cardium blandum, Gld.—R.
* Liocardium elatum, Sby.—R.
Cardita subquadrata, Cpr.—R., A.
Lucina californica, Conr.—R., A.
Diplodonta orbella, Gld.—R.
Diplodonta orbella, var.—R.
Kellia laperousii, Desh.—R.
Kellia suborbicularis, Mont.—R.
† Mytilus californianus, Conr.—R., A., C.
Mytilus edulis, Linn.—R., A.
Mytilus bifurcatus, Stearns—R., A.
Modiola modiolus, Linn.—R., A.
Adula falcata, Gld.—R.
† Septifer bifurcatus, Rve.—R.
Lithophagus plumula, Hanl.—R., C., A.
Axinæa intermedia, Brod.—R.
Axinæa septentrionalis, Midd.—R.
Pecten hastatus, Sby.—R.
Pecten hastatus, var. hindsii, Cpr.—R.
‡ Pecten aequisulcatus, Cpr.—R., A.
Pecten latiauritus, Conr.—R.
* Hinnites giganteus, Gray—R., A.
† Ostraæ lurida, Cpr.—R.
Succinea rusticana, Gld.—R.
Helix aryesiana, Newc.—R., C., A. (This species not heretofore reported fr Anacapas.)
Physa D'Orbigniana, Lea—R.
* Dentalium indianorum, Cpr.—R.
Chiton (Mopalia) muscosa, Gld.—R., A.
Chiton (Ischnochiton) scabra, Rve.—R., A.
† Chiton (Ischnochiton) magdalensis, Hds.—R.
Chitor (Ischnochiton) cooperi, Cpr.?—R., A.
Nacella (Acmæa) incessa, Hds.—R.
Nacella (Acmæa) paleacea, Gld.—R.
Acmæa patina, Esch.—R., A.
† Acmæa persona, Esch.—R., A.
† Acmæa scabra, Nutt.—R., A.
Acmæa spectrum, Nutt.—R.
Acmæa asmi, Midd.—A.
Acmæa crebrifilatum, Cpr.—R.
Acmæa crebrifilatum, var. —R.
Acmæa (Scurria) mitra, Esch.—R., C.
‡ Acmæa (Lottia) gigantea, Gray—R., C., A.
Gadenia reticulata, Sby.—R., C., A.
† Fissurella volcano, Rve.—R., A.
Fissurella (Glyphis) aspera, Esh.—R.
* Lucapina crenulata, Sby.—R., C., A.
Fissurellidæ (Clypidella) bimaculata, Dall.—R.
† Haliotis cracherodii, Leach.—R., C., A.
Haliotis corrugata, Gray—R., C., A.
Haliotis rufescens, Sw.—R., C., A.
Phasianella compta, Gld.—R.
Phasianella compta, var. pulloides, Cpr.—R.
* Pomaulax undosus, Wood—R., A., C.
Lepthothyra sanguinea, Cpr.—R.
Lepthothyra bacula, Cpr.—R., A.
Lepthothyra bacula, var.—R.
† Trochiscus norrisii, Sby.—R., A.
Chlorostoma funebrale, Ad.—R., C., A.

FIG. 3.



CHANNEL BETWEEN MIDDLE AND EAST ANACAPAS (LOOKING SOUTH)

stoma funebrale, var. subapertum, Cpr.—R., A.
ostoma brunneum, Phil.—R., C., A.
stoma aureo-tinctum, Fbs.—R.
stoma gallina, Fbs.—R., C., A.
oma canaliculatum, Mart.—R.
oma costatum, Mart.—R.
oma annulatum, Mart.—R.
oma gemmulatum, Cpr.—R.
oma splendens, Cpr.—R.
ita acuticostata, Cpr.—R.
ila dorsata, var. lingulata, Gld.—R.
ila adunca, Sby.—R., C.
ila navicelloides, Nutt.—R.
ila navicelloides, var. explanata, Gld.—R.
onyx antiquatus, Linn.—R., A.
iyx cranioides, Cpr.—R.
iyx tumens, Cpr.—R., A.
rbis squamigerus, Cpr.—R., A., C.
i compacta, Cpr.—A.
lyphus lituella, Morch?—A.
iidea sacrata, Gld.—R.
i filosum, Gld.—R.
i quadrifilatum, Cpr.—R.
i quadrifilatum, var.—R.
i asperum, Cpr.—R.
ia planaxis, Nutt.—R., A.
ia scutulata, Gld.—R., C., A.
ia scutulata, var.—R.
i variegata, Cpr.—R.
i unifasciata, Cpr.—R.
a (Cypræa) spadicea, Sw.—R., C., A.
(Cypræa) californica, Gray—R., A.
Cypræa) solandri, Sby.—R.
itellina, Hds.—R.
inermis, Hds.—R.
moesta, Cpr.—R.
torosa, Cpr.—R.
torosa, var. aurantii, Cpr.—R.
ia variegata, Cpr.—R.
ia interlirata, Sts.—R.
iorpha aspera, Cpr.—R.
s californicus, Hds.—R., C., A.
mia gravida, Gld.—R.
itzia tenuicula, Gld.—R.
i tincta, Cpr.—R., A.
i sp.—R., A.
i gracilis, Sby.—R., A., C.
crenatoids, Cpr. (or nov. sp?)—A., C.
opsis tuberculata, Mont.—R., A.
opsis assimilata, C. B. Ad.—A.
ia lewisii, Gld.—R., C.
aria stearnsiana, Dall.—R.
i californica, Hds.—A.
maura, Sw.—R., A.
na varia, Sby.—R., A.
la biplicata, Sby.—R., A.
ossata, Gld.—R.
ierpinguis, Hds.—R.
nendica, Gld.—R.
ooperi, Fbs.—R.
iella carinata, Hds., var. Hindsii, Rve.—A.
ssa corrugata, Rve.—R., A.
ssa corrugata, var. vesicolor, Dall.—R.
a canaliculata, Ducl.—R.
a saxicola, Val.—R.
a saxicola, var. fuscata, Fbs.—R.
a saxicola, var. emarginata, Desh.—R.
a crispata, var. septentrionalis, Rve.—C.
ros engonatum, Conr.—R., A.
ros, var. spiratum, Blain.—R.
ros lapilloides, Conr.—R., A.
a lurida, Midd.—R., A.
a lurida, var. aspera, Baird—A.
a interfossa, var. atropurpurea, Cpr.—R.
a interfossa, var. muricata, Coop.—R.

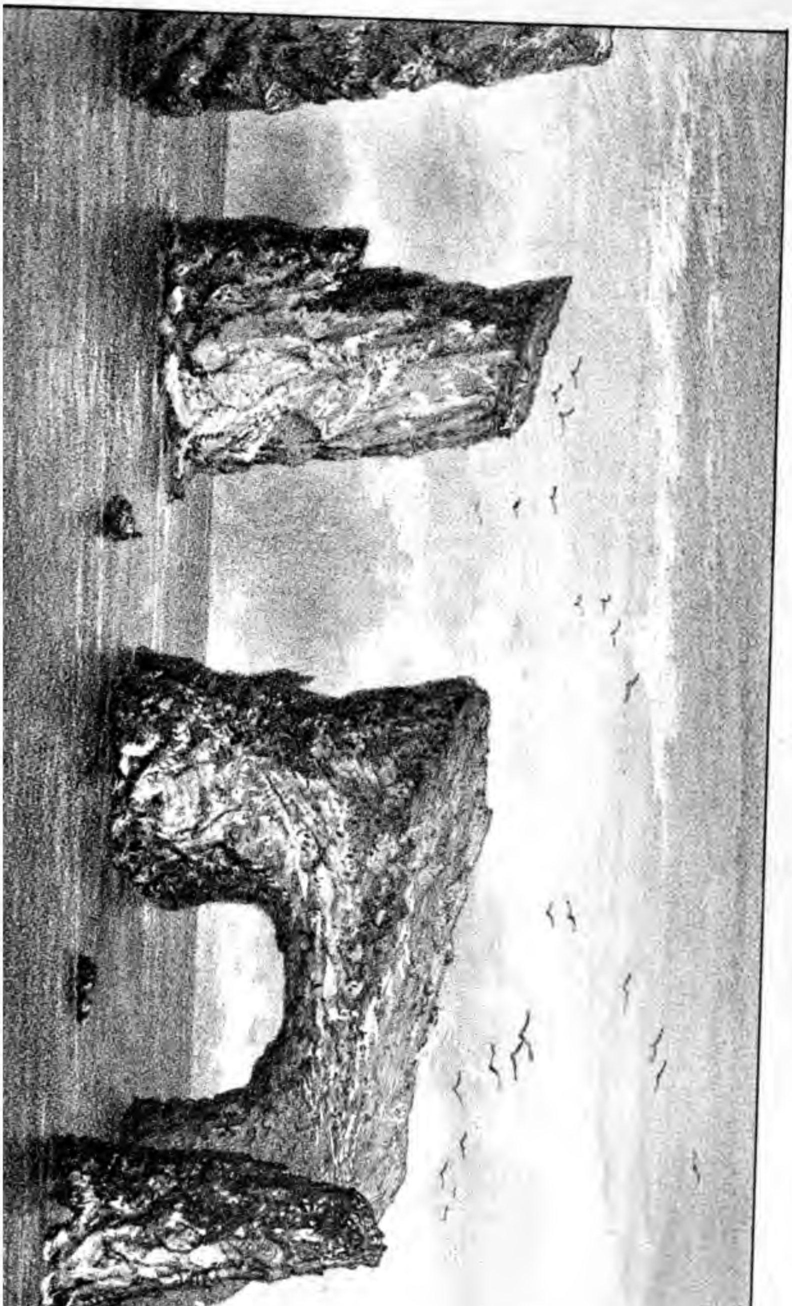
Ocinebra interfossa, var. clathrata, Cpr.—R.
Ocinebra intertexta, Sts.—R., A.
Cerostoma nuttalli, Conr.—A.
Nitidella gouldii, Cpr.—R.
Muricidea fasceolata, Hds.—R.
Muricidea incisa, Brod.—A.
Fusus cinereus, Rve.—A.
Anachis penicillata, Cpr.—R.

Cephalopoda.

Argonanta argo, Linn.—C.
Ommatostrephes gigas, D'Orb.—R.

Doubtless a thorough examination of the shores of these islands would result in the finding of numerous species not included above. Such examinations must necessarily extend over various seasons of the year, and also many years' observations, before a full and complete list of the mollusca could be compiled. Some species appear only at long intervals, and then only under certain conditions, or combinations of favorable circumstances, as to the season of the year, and storms coming from certain directions.

NOTE.—Since the above list was compiled Dr. J. Walter Fewkes has published an illustrated description of a new genus of Nudibranchiata discovered at Santa Cruz Island, which he has named *Cabrilla*, from Cabrillo, the discoverer of the islands. The species is Cabrilla occidentalis, *Fewkes*.



INSULAR FLORAS.

By Dr. Lorenzo G. Yates, F.L.S.

Ir. Alfred R. Wallace, who has written more than any other writer on subject of differences and variations existing between the floras and nas of continents and islands, and the general distribution of plants animals, claims that the floral and faunal variations between islands the continents to which they are contiguous—widely separated contits, and others which are less distant—involve the study, and illustrate e of the general history of the earth, than any other subject with which are acquainted; consequently, it represents more fully the great Book ature.

y this study we may find pages which, when deciphered, will be more resting and replete with valuable information to its students than any r line of research in that direction.

very continent and every island offers problems, the solution of which present paragraphs and chapters of the past history of the earth.

he correct solution of these problems, based upon the visible and known litions of the present time, show the combined results of geological, graphical, meteorological, and other changes, which have caused the ution and distribution of the fauna and flora, not only of the present, also of all past epochs.

ature never rests. Annihilation as applied to natural objects is a mister. Life and death are but terms applied to phases in the nature of gs, which are ever undergoing change.

hange is the life of nature, as circulation and growth are the result of in plants and animals; and as seemingly insignificant circumstances erially alter the course of the lives of men, so, what we might deem nportant and scarcely perceptible changes in the condition and surdings of inorganic matter, eventually affect the organisms of plants animals. The falling of a tree, the breaking down of a shrub, and the turning of a stone, affects the condition of some insect or other nism, and the results of the change will continue through all time. ry portion of the surface of the earth is exposed to the changing influs of sun, wind, rain, frost, and snow, which, by their direct action, y attrition, caused by particles being brought in contact with other stances, form new combinations and changes in its topography.

here are regularly recurring cycles of climatic changes, corresponding he diurnal and annual changes of relationship between the earth and , which eccentricities, as they have been termed, extend over so great riod of time that we cannot measure them with any degree of certainty. se eccentricities have been less marked during the period of which we e any satisfactory knowledge back to perhaps sixty thousand years ago, ch period has been marked by a comparative stability of climate, and represent the prime of life of our earth, and may be followed by a line, manifested by a gradual diminution of the forces which have ved and developed organic life, a more rapid and gradually increasing lification, disintegration, and distribution of the inorganic matter, cor-

responding with the decline of organic life, until the earth shall cease to exist as a planet, and return to a gaseous or nebulous state, to be again distributed in space, and incorporated with other matter of like character and formed into new worlds, thus continually carrying out the everchanging condition of forces and matter which we call Nature.

The floras of some high and isolated mountain peaks also present interesting chapters in the earth's history. The summit of the White Mountains, in New Hampshire, has a vegetation, every plant of which is identical with species growing in Labrador, and the butterflies are also Arctic species; the highest peaks of the Alps and the Pyrenees contain a number of plants like those of Labrador, and some of the high volcanic peaks of Java produce plants allied to those of Europe, while the lowlands for thousands of miles are occupied by a flora of an entirely different character. These mountains produce living representatives of the plants which occupied the surrounding country during the glacial epoch, when the present temperate regions were subjected to intense cold. The gradual return of the warm climate caused remnants of the Arctic flora to recede from the valley, up the slopes of the mountains, at the summits of which are now found species identical with those found growing in the present Arctic region, while their former places, at lower altitudes, are now occupied by floras of temperate or tropical climates. The discovery of large numbers of fossil plants of a well marked tropical character in Greenland, Alaska, etc., shows that at a time still more remote the present Arctic regions enjoyed the benefits of a tropical climate.

We have in California interesting and well marked illustrations of the peculiarity and individuality, as it were, of insular floras.

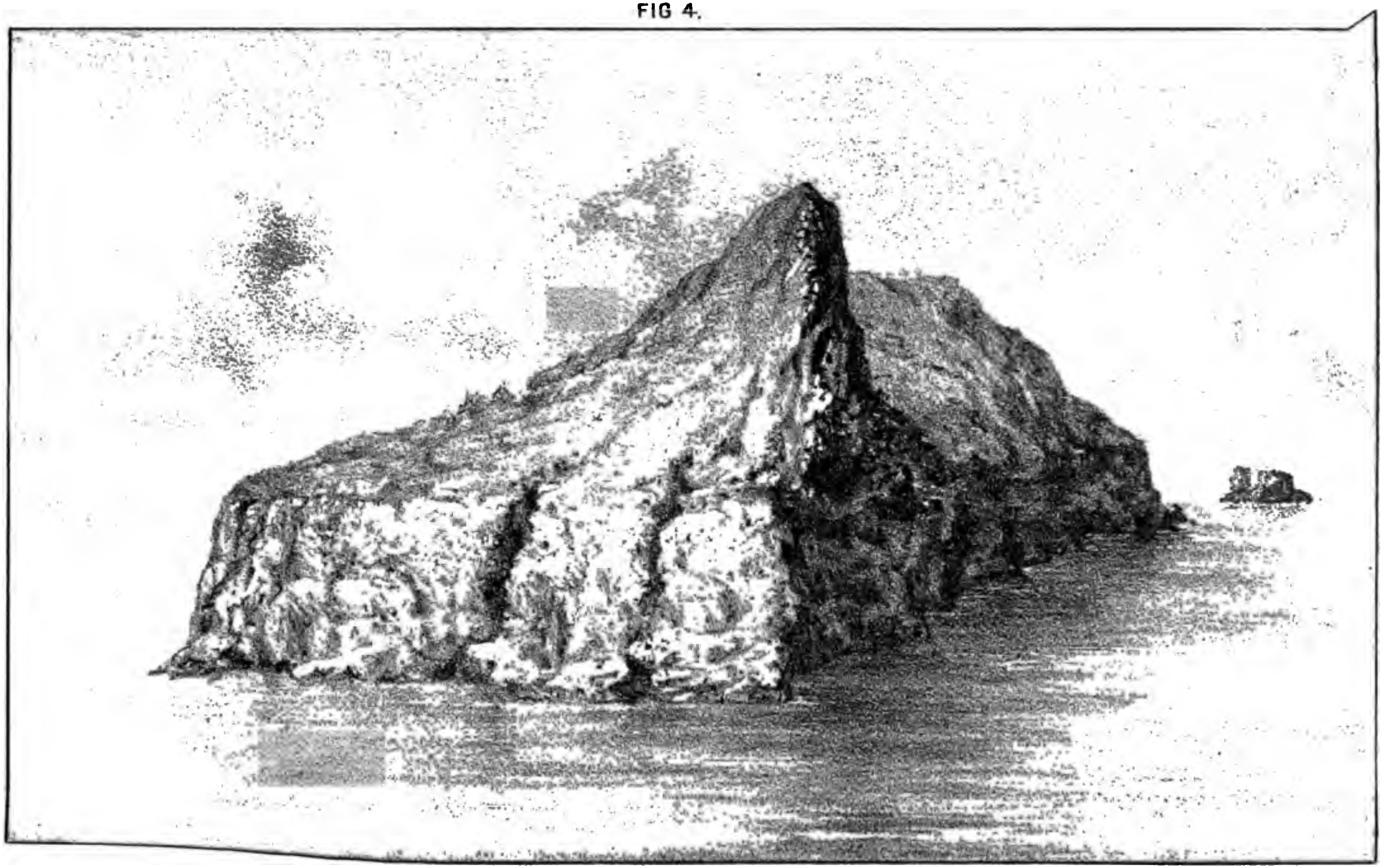
The islands of San Miguel, Santa Rosa, Santa Cruz, and the Anacapas, which form the seaward or southern wall of Santa Barbara Channel, although but partially explored, have already furnished our botanists with a long list of new and (except on these islands) unknown plants. Prof. E. L. Greene, during a short stay upon Santa Cruz Island in 1886, discovered twenty-eight species of plants peculiar to that island, so far as our present knowledge goes, and twenty of which are peculiar to Santa Cruz and the other islands off our coast. Professor Greene remarks that "a small ridge of mountains rising out of the sea at only twenty-five miles distant from the mainland shore should present forty-eight species of phanerogamic plants not to be found on the continent itself is, to my understanding of the case, a fact entirely unique in phytogeography, and I cannot but wonder if competent geological authority will not, after careful investigation, assure us that this group of islands has a very peculiar geological origin and history."

Professor Greene also considers that the several distinctively Californian species of Dendromecon, Eschscholtzia, Thysanocarpus, and Zauschneria have been carried from the islands to the mainland, and that several of the rare species of our southern counties have also been distributed from Santa Cruz.

The two new generic types, which are endemic on the islands, are the Lyonothamnus and Hazardi. The genus Lavatera is not represented on Santa Cruz, but the more southern islands have given us four species. The question is how did those insular genera and species orignate?

These islands are of comparatively recent geological formation, perhaps of the miocene tertiary. As no living nor fossil representatives of these species have been found elsewhere, we must infer that they originated on these islands; consequently the genera and species have evolved or been *created within* recent geological epochs. It would also indicate that new

FIG 4.



ıre continually being evolved in, and distributed from, various cen- ortions of the earth's surface.

ıyonothamnus is a tree with a beautiful and, as the name of one ɔecies (Asplenifolia) indicates, fern-like foliage, and special effort ıe made to cultivate and distribute it.

with append a tabulated list of the known flora of the Channel showing the collections made by Prof. E. L. Greene, Prof. Bran- rof. H. C. Ford, and Dr. L. G. Yates:

TED LIST OF THE KNOWN FLORA OF THE CHANNEL ISLANDS OFF THE COAST OF SOUTHERN CALIFORNIA, TO 1890.

'he initials in the spaces under the names of the different islands indicate who ted the species on the particular island, and where more than one individual ted the species on the same island, the initial of the name of each collector is

icates Prof. E. L. Greene.
icates Prof. Brandegee.
icates Prof. H. C. Ford.
icates Dr. L. G. Yates.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapas.
igusticifolia, *Nutt.*		B.	G.	
us Californicus, *Benth.*		B.		
us Deppei, *Nutt.*	G.		G.	
m Parryi		B.		
›innata, *Lagasca*			G.	
on Californicus, *Benth.*	G.	B.	G.	
na denticulatum, *Greene*			G.	
is heterophylla, *Benth.*			G., F.	
›con flexile, *Greene*		B.	F., Y.	
tzia glauca, *Greene*		B.	G.	
tzia maritima, *Greene*	G.			
tzia ramosa, *Greene*			G.	
e integrifolia, *Torr. & Gray*			G.	
folia, *Greene*			G.	
·foliata, *Lam.*			B.	
:uata, *Gray*			B.	
um lasiophyllum, *Greene*	G.		G.	
um laciniatum, *Endl.*			F.	
m pinnatum			G.	
m officinale, *Scop.*			G.	
m reflexum, *Nutt.*		B.		
ı insulare, *Greene*	G.	B.		
ı asperum, *DC.*			B.	
ampestris, *Linn.*	G.		B.	
igra, *Boiss.*			G.	
m aquaticum, *Tragus*			G.	
ivaricata, *Walp.*	G.	B.	G.	
Bursa-pastoris, *Mœnch*			G.	
nitidum, *Nutt.*			G.	
lasiocarpum, *Nutt.*	G.			
lasiophyllum, *Nutt.*		B.		
Menziesii, *DC.*			G.	
arpus conchuliferus, *Greene*			G.	
arpus ramosus, *Greene*			G.	
ırborea, *Nutt.*		B.		
s pusillus, *Greene*			G.	
ınculata, *Torr. & Gray*		B.		
s subulata, *Boiss.*	G.		G.	
mum scoparium, *Nutt.*		B.	G.	
mum occidentale, *Greene*			G.	
ı grandifolia, *Cham. & Sch.*	G.	B.	G.	Yates.
Douglasii, *Torr. & Gray*			B.	
ulans, *Greene*	G.			
oidea, *L.*			B.	
rrhina, *Linn.*	G.		G.	
lica, *Linn.*	G.	B.	G.	
ıquevulnera, *Linn.*			G.	

List of the Known Flora—Continued.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapa.
Silene laciniata, *Cav.*	G.		G.	Yates.
Stellaria media, *Sm.*		B.	G.	
Sagina occidentalis, *Watson*		B.	G.	
Lepigonum macrothecum, *Fisch & Mey.*	G.		G.	
Pentacæna ramosissima, *Hook*		B.	G.	
Calandrinia maritima, *Nutt.*			B.	
Calandrinia Menziesii, *Hook*			G.	
Calandrinia Brewerii, *Watson*			B.	
Claytonia perfoliata, *Donn.*		B.	G.	
Malva parviflora, *Linn.*		B.	G.	
Lavatera assurgentiflora, *Kellogg*	G.	Y.		
Sidalcea malvæflora, *Gray*	G.	B.		
Malvastrum Thurberi, *Gray*, var. laxiflorum, *Gray*			G.	
Malvastrum exile, *Gray*			B.	
Erodium cicatarium, *l'Her.*	G.	B.	G.	
Erodium moschatum, *Willd*	G.		G.	
Erodium macrophyllum, *Hook & Arn.*			B.	
Rhamnus insularis, *Kellogg*	G.		G.	
Ceanothus crassifolius, *Torr.*	G.	B.	G.	
Ceanothus arboreus, *Greene*		B.	G.	
Acer macrophyllum, *Pursch.*			G.	
Rhus diversiloba, *Torr. & Gray*	G.	B.	G.	
Rhus integrifolia, *Benth.*	G.	B.	G.	
Rhus ovata, *Watson.*			G.	
Lupinus arboreus, *Linn.*	G.			
Lupinus Chamissonis, *Esch.*	G.	B.	G.	
Lupinus affinis, *Agh.*			G.	
Lupinus nanus, *Dougl.*			G.	
Lupinus truncatus, *Nutt.*			G.	
Lupinus hirsutissimus, *Benth.*			G.	
Lupinus umbellatus, *Greene*		B.	G.	
Lupinus microcarpus, *Linn.*			G.	
Lupinus concinnus, *Agardh.*			B.	
Oxalis Wrightii, *Gray*			B.	
Geranium Carolinianum, *L.*			B.	
Astragalus nigrescens, *Nutt.*			B.	
Astragalus Miguelensis, *Greene*	G.	B.		Yates.
Astragalus lucopsis, var. brachypterus, *Greene*	G.			
Astragalus didymocarpus, *Hook & Arn.*			G.	
Astragalus lucopsis, *Torr. & Gray*			G.	
Medicago sativa, *Linn.*	G.			
Medicago denticulata, *Willd.*	G.		G.	
Melilotus parviflora, *Desf.*	G.	B.	G.	
Godetia purpurea, *Watson*			G.	
Godetia quadrivulnera, *Spach.*		B.	B.	
Godetia epilobioides, *Watson*			G., F.	
Œnothera nitida, *Greene*	G.			
Œnothera Hookeri, *Torr. & Gray*			G.	
Œnothera micrantha, *Hornem*			Ford.	
Œnothera dentata, *Cav.*		B.		
Œnothera bistorta, *Nutt.*	G.	B.	G.	
Œnothera cheiranthifolia, *Hornem*	G.	B.	G.	
Syrmatium dendroideum, *Greene*		B.	G., F.	
Syrmatium patens, *Greene*	G.		G.	
Syrmatium niveum, *Greene*			G.	
Trifolium tridentatum, *Lindl.*			F.	
Trifolium microcephalum, *Pursh.*			F.	
Hosackia occulta, *Greene*			G.	
Hosackia grandiflora, *Benth.*			B.	
Hosackia parviflora, *Benth.*			G.	
Hosackia strigosa, *Nutt.*		B.	G.	
Hosackia maritima, *Nutt.*		B.	G.	
Hosackia subpinnata, *Torr. & Gray*			G.	
Hosackia Purshiana, *Benth.*			G.	
Vicia Americana, *Muhl.*			G.	
Vicia exigua, *Nutt.*	G.		G., F.	
Pickeringia montana, *Gray*			B.	
Lathyrus vestitus, *Nutt.*			G.	
Prunus occidentalis, *Lyon*		B.	G.	

LIST OF THE KNOWN FLORA—Continued.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapas.
sinus, *Cham.*	G.	B.	G.	
›us betulæfolius, *Nutt.*			G.	
anserina, *Linn.*	G.			
ma fasciculatum, *H. & A.*		B.	G.	
fornica, *Cham. & Schl.*		B.	G.	
scolor, *Pursh.*			B.	
les arbutifolia, *Rœmer*	G.	B.	G.	
mnus asplenifolius, *Greene*			G., F., Y.	
a arvensis, *Scopoli*			B.	
malvæfolia, *Greene*			G.	
reflexa, *Hook*			B.	
maxima, *Greene*		B.	G.	
vestitum, *Hook & Arn.*			G.	
guinea, *Pursh.*; var. malvaceum, *Gray*			B.	
nziesii, *Pursh.*			B.	
ymbalaria, *Gray*			B.	
nima, *Miers*		B.	G., F.	
lanceolata, *Watson*	G.	B.	G.	Yates.
laxa, *Watson*			G.	
Californicum, *T. & G.*			G.	
ria Californica, *Presl.*	G.	B.	G.	
ria villosa, *Greene*			G.	
ria cana, *Greene*			G.	
coloratum, *Muhl.*			G.	
Californicus, *Nutt.*			G.	
egans, *Dougl.*		B.	G.	
micrantha, *Greene*		B.	G.	
stis macrocarpa, *Greene*	G.	B.	G.	
stis Guadalupensis, *Cogn.*	G.		G.	
				Yates.
Engelmanni, *Salm.*; var.? littoralis, *En-*	G.	B., Yates.	G.	Yates.
anthemum aequilaterale, *Haw.*	G.		G.	
anthemum crystallinum, *Linn.*	G.	B., Y.	G.	
aciniata, *Hook & Arn.*			G.	
aculatum, *Linn.*			G.	
m officinale, *All.*			G.	
n augustifolium, *Nutt.*	G.		G., Ford.	
gustifolia, *Koch.*	G.		G.	
um caruifolium, *Torr. & Gray*		B.	B.	
usillus, *Michx.*	G.	B.	G., F.	
glauca, *Nutt.*		B.	G.	
carpus mollis, *Nutt.*		B.	G.	
hispidula, *Dougl.*			G.	
subspicata, *Hook & Arn.*		B.	G.	
parine, *Linn.*		B.	G.	
igustifolium, *Nutt.*		B.	G.	
accidum, *Greene*			G.	
axifolium, *Greene*	G.		G.	
uttallii, *Gray*			B.	
iguelensis, *Greene*	G.	B.		
Californica, *Gray*			G.	
robusta, *Nutt.*			G.	
latifolia, *Kellogg*		B.	G.	
colula, *L.*		B.		
us squarrosus, *Hook & Arn.*			G.	
us ericoides, *Hook & Arn.*	G.			
veneta, *Gray*	G.	B.	G.	
veneta, var. sedoides, *Greene*	G.		G.	
Californica, *Nutt.*		B.	G.	
yne filaginifolia, *Nutt.*		B.	G.	
yne filaginifolia, var. robusta, *Greene*	G.			Yates.
detonsa, *Greene*		B.	G.	
serrata, *Greene*		B.	G.	
aceus, *Lindl.*		B.		
ulinus, *Gray*			G.	
canadensis, *Linn.*			G.	
glaucus, *Ker.*	G.	B.	G.	Yates.
stenophyllus, *Nutt.*	G.		G.	

LIST OF THE KNOWN FLORA—Continued.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapa.
Erigeron foliosus, *Nutt.*		B.		
Erigeron sancturum, *Wats.*		B.		
Conyza Coulteri, *Gray*			G.	
Baccharis pilularis, *DC.*		B.		
Baccharis consanguinea, *DC.*			G.	
Baccharis plummeræ, *Gray*			G.	
Baccharis Douglasii, *DC.*		B.	G.	
Baccharis viminea, *DC.*			G.	
Bæria gracilis, *Gray*		B.	B., F.	Yates.
Bæria Palmeri, var. Clementina, *Gray*		B.	G.	
Micropus Californicus, *F. & M.*			G., F.	
Microseris Lindleyi, *Gray*		B.	B.	
Microseris elegans, *Greene*			B.	
Microseris linearifolia, *Torr. & Gray*		B.		
Microseris anomala, *Watson*			B.	
Filago Californica, *Nutt.*		B.	G., F.	
Gnaphalium sprengelii, *Hook & Arn.*	G.	B.	G.	
Gnaphalium ramosissimum, *Nutt.*			G.	
Gnaphalium decurrens, var. Californicum, *Gray*		B.	G.	
Gnaphalium purpureum, *Linn.*		B.	G.	
Ambrosia psilostachya, *DC.*			G.	
Franseria bipinnatifida, *Nutt.*	G.		G.	
Franseria Chamissonis, *Less.*	G.			
Xanthium canadense, *Mill.*			G.	
Helianthus annuus, *Linn.*			G.	
Encilia Californica, *Nutt.*			G.	
Leptosyne gigantea, *Kellogg*	G.	B.	G.	Yates.
Madia filipes, *Gray*			G., Ford.	
Madia sativa, *Molina*		B.		
Madia dissitifolia, *Torr. & Gray*			B.	
Hemizonia fasciculata, *Torr. & Gray*	G.	B.	G.	
Hemizonia paniculata, *Gray*		B.		
Achyrachæna mollis, *Schauer*			G.	
Layia platyglossa, *Gray*	G.	B.	G., F.	
Venegasia carpesioides, *DC.*		B.	G.	
Perityle Fitchii, *Torr.*			G.	
Eriophyllum confertiflorum, *Gray*	G.		G.	
Eriophyllum stachdifolium, *Greene*		B.	G.	
Amblyo pappus pusillus, *Hook & Arn.*	G.	B.	G.	Yates.
Achillea Millefolium, *Linn.*	G.	B.	G.	
Artemisia Californica, *Less.*	G.	B.	G.	Yates.
Artemisia Ludoviciana, *Nutt.*		B.	G.	
Lepidospartum squamatum, *Gray*			G.	
Stylocline gnaphaloides, *Nutt.*		B.	B.	
Matricaria discoidea, *DC.*			B.	
Senecio vulgaris, *L.*			B.	
Senecio Douglasii, *DC.*			G.	
Cnicus lilacinus, *Greene*	G.			
Cnicus occidentalis, *Gray*	G.			
Chænactis tenuifolia, *Nutt.*		B.		
Silybum marianum, *Gært.*			G.	
Centaurea melilensis, *Linn.*	G.	B.	G.	
Perezia microcephala, *Gray*		B.	G.	
Stephanomeria elata, *Nutt.*			G.	
Stephanomeria exigua, *Nutt.*		B.		
Stephanomeria virgata, *Benth.*	G.	B.	G.	
Stephanomeria tomentosa, *Greene*			G.	
Stephanomeria cichoriacea, *Gray*			G.	
Rafinesquia Californica, *Nutt.*			G.	
Hypochæris glabra, *Linn.*			G.	
Calais linearifolia, *DC.*			G.	
Calais pluriseta, *Greene*			G.	
Malacothix tenuifolia, *Torr. & Gray*	G.		G.	Yates.
Malacothix Coulteri, *Gray*			B.	
Malacothix incana, *Torr. & Gray*	G.	B.	G.	
Malacothix Clevelandi, *Gray*			B.	
Malacothix indecora, *Greene*	G.		G.	
Malacothix saxatalis, *Torr. & Gray*		B.		
Malacothix squalida, *Greene*			G.	

LIST OF THE KNOWN FLORA—Continued.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapas.
:arnosa, *Gray*	G.			
m argutum, *Nutt.*		B.	G.	
ı grandiflorum, *Gray*		B.		
ı heterophyllum, *Greene*			G.	
oleraceus, *Linn.*		B.	G.	
asper, *Fuchs*		B.	G., F.	
a biflora, *Gray*			B.	
a perfoliata, *A. DC.*			G.	
m ovatum, *Pursh.*			G.	
ɔhylos tomentosa, *Dougl.*		B.	G.	
ɔhylos pungens, *H. B. K.*		B.	G.	
ɔhylos diversifolia, *Parry*		B.	G.	
ɔhylos Stanfordi, *Parry*			Ford.	
ıeon Hendersoni, *Gray*		B.		
ıeon Jeffreyi, *Moore*			G.	
Valerandi, var. Americanus, *Gray*			G.	
ı Douglasii, *Gray*		B.	G.	
ırosacea, *Steud.*		B.	B.	
ɔlia, *Nutt.*			G.	
ıthoides, *Endl.*			B.	
rantha, *Steud.*	G.			
inii, *Gray*		B.	B.	
.ticaulis, *Benth.*			G.	
la aurita, *Lindl.*			B.	
la parviflora, *Dougl.*			B.	
la racemosa. *Nutt.*			G.	
. chrysanthemifolia, *Greene*	G.	B.	G.	
distans, *Benth.*		B.	B.	
viscida, *Torr.*	G.	B.	B.	
ramosissima, *Dougl.*		B.		
scabrella, *Greene* (=distans?)	G.	B.		
hispida, *Gray*			G.	
suffrutescens, *Parry*			G.	
Parryi, *Torr.*			G.	
Douglasii, *Torr.*			Ford.	
nthe penduliflora, *Benth.*			G.	
ɾa penicillata, *A. DC.*			G.	
ia leiocarpa, *Fisch. & M.*	G.	B.	G.	
ia micromeres, *Gray*			G.	
ia Jonesii, *Gray*			G.	
:hrys canescens, *Benth.*			B.	
:hrys Californicus, *Gray*			G.	
ırya penicillata, *A. DC.*			Ford.	
›ium Curassavicum, *Linn.*	G.		G.	
ia lycopsoides, *Lehm.*	G.		G.	
ia intermedia, *F. & M.*		B.	G.	
etica, *Linn.*	G.			
ılus pentapetaloides, *L.*			B.	
.lus macrostegius, *Greene*	G.	B.	G.	Yates.
ılus arvensis, *Linn.*			G.	
ıubinclusa, *Dur. & Hil.*			G.	
'a argentea, *Willd.*		B.		
Douglasii, *Dunal*	G.	B.	G.	
Xanti, var. Wallacei, *Gray*		B.	G.	
ıeteloides, *DC.*			G.	
ı Clevelandi, *Gray*			G.	
anadensis, *Dum.*		B.	G.	
ıum nuttallianum, *Benth.*	G.	B.	G.	
ıum strictum, *Gray*			G.	
ɔn cordifolius, *Benth.*		B.	G.	
arachnoideus, *Greene*		B.	G.	
parviflorus, *Greene*		B.	G.	
cardinalis, *Dougl.*			G.	
latifolius, *Gray*			B.	
nasutus, *Greene*		B.	G.	
floribundus, *Dougl.*			G.	
lutens, *L.*			B.	
affinis, *Hook & Arn.*			G.	Yates.
hololeuca, *Greene*	G.	B.	G.	Yates.

List of the Known Flora—Continued.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapa.
Castilleia parviflora, *Brong.*		B.	B., Ford.	
Orthocarpus densiflorus, *Benth.*	G.		G.	
Orthocarpus purpurascens, *Benth.*		B.		
Collinsia bicolor, *Benth.*		B.		
Aphyllon fasciculatum, *Gray*			B.	
Aphyllon tuberosum, *Gray*		B.	G.	
Verbena prostrata, *R. Br.*	G.		G.	
Sphacele fragrans, *Greene* } Sphacele calycina, *Benth.?* }		B.	G.	
Salvia Columbariæ, *Benth.*		B.	G.	
Audibertia Palmeri, *Gray*			G.	
Audibertia nivea, *Benth.*			B.	
Audibertia stachyoides, *Benth.*			B.	
Audibertia stachyoides, var. revoluta		B.		
Stachys acuminata, *Greene*			G.	
Scutellaria tuberosa, *Benth.*			B.	
Marrubium vulgare, *Linn.*	G.			
Plantago major, *Camerarius*			G.	
Plantago patagonica, *Jacq.*	G.	B.	G.	
Plantago hirtella, *H. B. K.*	G.			
Salicornia ambigua, *Michx*	G.	B.	G.	
Eriogonum grande, *Greene*		B.	G.	
Eriogonum rubescens, *Greene*	G.	B.	G.	
Erigonum arborescens, *Greene*		B.	G.	Yates.
Rumex salicifolius, *Weinn.*	G.	B.	G.	
Rumex crispus, *Linn.*			G.	
Rumex maritimus, *Linn.*	G.		G.	
Rumex conglomeratus, *Murr.*			G.	
Polygonum aviculare, *Linn.*		B.	G.	
Chorizanthe staticoides, *Benth.*		B.	G.	
Pterostegia drymarioides, *F. & M.*		B.	G.	
Mirabilis Californica, *Gray*			G.	
Abronia maritima, *Nutt.*	G.		G.	
Abronia umbellata, *Lam.*	G.	B.	G.	
Amarantus albus, *Linn.*			G.	
Chenopodium murale, *Linn.*			G.	
Chenopodium album, *Linn.*	G.	B.	G.	
Chenopodium ambrosioides, *Linn.*		B.	G.	
Chenopodium Californicum, *Watson*	G.		G.	
Atriplex microcarpa, *Dietr.*			G.	
Atriplex Californica, *Moq.*	G.	B.	G.	
Atriplex leucophylla, *Dietr.*	G.		G.	
Atriplex Breweri, *Watson*			G.	Yates.
Suæda Torreyana, *Watson*	G.		G.	
Urtica holosericea, *Nutt.*			G.	
Urtica urens, *Linn.*			G.	
Parietaria debilis, *Forst.*		B.	G, Ford.	
Eremocarpus setigerus, *Benth.*			G.	
Ricinus communis, *Linn.*			G.	
Salix lævigata, *Bebb.*		B.	G.	
Salix longifolia, *Muhl*			G.	
Salix lasiolepis, *Benth.*			G.	
Populus Fremonti, var. Wislizeni, *Watson*			B.	
Populus trichocarpa, *Torr.*		B.	G.	
Quercus agrifolia, *Liebm.*		B.	G.	
Quercus chrysolepis, *Liebm.*			G.	
Quercus dumosa, *Nutt.*		B.	G.	
Quercus lobata, *Nee.*		B.	B.	
Quercus parvula, *Greene*			G.	
Quercus tomentella, *Englm.*		B.	G.	Only k'wn loc. in U.S.
Pinus insignes, *Dougl.*; var. binata, *Englm.*		B.	G., F., Y.	
Pinus Torreyana, *Parry*		B., Y.		
Allium lacunosum, *Watson*		B.	B.	
Allium hyalinum, *Curran*			B.	
Calochortus albus, *Dougl.*		B.	B.	
Calachortus venustus, *Benth.*			B.	
Brodiæa minor, *Watson*			B.	
Brodiæa insularis, *Greene*	G.	B.	G.	

LIST OF THE KNOWN FLORA—Continued.

	San Miguel.	Santa Rosa.	Santa Cruz.	Anacapas.
legans, *Bolander*		B.	G.	
n bellum, *Watson*	G.	B.	G.	
urea, *Kellogg*		B.	G.	
iboldtii, *Roezl.*		B.	G.	
›sa, *Meyer*		B.	B.	
'remonti, *Torr.*		B.	G.	
ns, *Meyer*		B.		
cus, *Deth.*	G.	B.	G.	
us, *Linn.*			G.	
nius, *Linn.*		B.	G.	
eata, *Greene*			G.	
ina, *Linn.*			G.	
x Torreyi, *Watson*		B.	G.	
tata, *Boot.*			G.	
asii, *Boot.*		B.		
ıa, *Boot.*			B.	
gens, *Bahl.*		B.		
rius, *Spreng.*			B.	
uleri, *Trin.*		B.		
ticillata, *Vill.*		B.		
ıtus, *L. f.*			B., Ford.	
›kerianus, *Thurb.*		B.	B.	
tata, *Pers.*		B.	B.	
ırus, *Linn.*	G.	B.	G.	
rostachys, *Nutt.*		B.	B.	
›lla, *Willd.*			B.	
ia debilis, *Trin.*			G., F.	
ntha, *Trin.*			Ford.	
L.			B.	
i, *V. & S.*			B.	
›rmedia *Bosc.*			B.	
.rbatum, *Steud.*			B.	
a, *Presl.*		B.	B.	
ıs, *Cav.*			B.	
a, *Trin.*			B.	
Monspeliensis, *Desf.*	G.	B.	G.	
, *Linn.*	G.		G.	
rfecta, *Trin.*			G.	
›icata, *Linn.*	G.	B.	G.	
densatus, *Presl.*	G.	B.	G.	
repens, *Beauv.*	G.	B.	G.	
urinum, *Linn.*		B.	G.	Yates.
Telmateia, *Ehrh.*			B.	
Californicum, *Kaulf.*		Yates, B.	F., G., Y.	
Scouleri, *H. & G.*			Yates.	
hopus, *Hook*			F., G., Y.	
›medæfolia, *Fee.*		Yates, B.	F., G., Y.	
omedæfolia, var.			Y.	
Californica, *Melt.*			G.	
myriophylla, *Desv.*			F., B., Y.	
candida, *Hook*			G.	
na, *Linn.*		Y., B.	F., G., Y.	
edatum, *Linn.*			F., G., Y.	
apillus-veneris, *Linn.*			G.	
marginatum, *Hook*		Y., B.	B., Y.	
ı radicans, *Sm.*			F., G., Y.	
ıunitum, *Kaulf.*			G.	
›gidum, *Swtz.*		Y., B.	F., G., Y.	
ıme triangularis, *Kaulf.*		Yates, B.	B., F.	
ıme triangularis, var.			Y.	
upestris, *Spring.*			B.	
latifolium, *Sm.*				Yates.
Streetsii, *Gray*				Yates.

›mizonia Streetsii, *Gray*, heretofore collected only on Santa Catalina and San lands by W. S. Lyon, collected by L. G. Yates on Anacapas, is new to the ›up.

Lichens Collected on Anacapas by H. C. Ford and L. G. Yates, determined by Prof. W. G. Farlow.

	Anacapas.
Rawalina ceruchis, *Achs.*	F., Y.
Rawalina howalea, *Ach.*	F., Y.
Placodaim aurantiacum, *N. & H.*	F., Y.
Rocella leucophœa, *Tuck.*	F., Y.
Rocella phycopsis, *Mont.*	F., Y.
Buellia pullata, *Tuck.*	F., Y.

LOS ANGELES COUNTY.

By E. B. PRESTON, E.M., Assistant in the Field.

Los Angeles County is situated between 33 degrees 25 minutes and 34 degrees 50 minutes north latitude, and 40 degrees 36 minutes and 41 degrees 55 minutes west longitude from Washington; therefore one of the southern counties of California. The general shape of the county is a parallelogram seventy miles long, from north to south, with a triangle added in the southeast portion, whose north line is seventy miles and east line forty miles.

It is bounded on the north by Kern County, on the east by San Bernardino County, south by San Diego County, and west by Ventura County and the ocean. It comprises an area of five thousand six hundred square miles, or about three million five hundred and eighty-four thousand acres, a large proportion of which is mountainous, and in the northern portions it is covered to some extent by the Mojave Desert. On the ocean side it has a shore line extending ninety miles, but without any prominent harbor. Santa Monica Bay and Ballona Harbor can be made into good harbors.

It has three principal rivers—the Santa Ana, which rises in San Bernardino County and runs west and south through Los Angeles County until it approaches the ocean, where it spreads out and, running parallel with the sea for some distance, finally discharges into the ocean near Newport. The San Gabriel takes its source in the San Bernardino Range. It has two forks, of which the west fork rises in Township 2 north, Range 11 west, S. B. M., and the different creeks that go to form the east branch take their rise in the mountains forming the southern boundary of the desert, in Township 3 north, Range 8 west, S. B. M. The two forks unite in Section 29, Township 2 north, Range 8 west, S. B. M., and flow thence south until they reach the ocean at Alamitos Bay. The Los Angeles River rises in the mountains near the Ventura County line, and running thence east and south, sinks in the neighborhood of Compton.

All of these streams, on the upper part of their course, are torrential, contributing thereby largely to the topographical changes that take place on the mountain flanks and in the cañons, causing denudations of large areas in one place and throwing up accumulations of wash and debris in others. Changes of the water level of ten and twelve feet in less than half an hour in the cañons are frequently recorded. Yet, notwithstanding the large amount of water that passes over these river-beds for the greater part of the year, the water sinks beneath the surface before reaching the ocean.

The mountain ranges are in the northeast—the San Bernardino Range, the main east and west ranges known as the Sierra Santa Inez; the Sierra Santa Monica, which flanks the coast extending from the ocean to the Cahuengo Pass. The Sierra Santa Susanna is north of San Fernando Valley. The principal northwest and southeast chains are less clearly defined as separate ranges; the principal portion is known as the Santa Lucia Range. It extends as a succession of high mountain crests from northeast of San Luis Obispo to Carmelo Bay, a distance of nearly one

hundred miles. The southeast end terminates in the Arroyo Grande. This whole chain with its outlying spurs is called on the Pacific railroad map Sierra de las Salinas.

The general trend of the east and west ranges is north 60 degrees west, and this seems to be the line of upheavals which mark the northeast limit of the coast ranges along the line of the desert. The region embraced between these hills is in general poorly supplied with water, the hills covered with a dense growth of chaparral, and with a forest growth on the side next to the ocean. The backbone of the main ranges consists of metamorphic rocks, syenites, gneiss, micaceous schists, with dikes of diorite.

A large part of the northeast of the county, comprising about twenty townships, is occupied by the Mojave Desert, a flat, sandy country cut up by ranges of low-lying hills of tertiary origin, without water.

METALS AND MINERALS.

The mineral and metallic productions of the county include gold, silver, copper, asphaltum, petroleum, graphite, iron, limestone, gypsum, borate of lime, magnesia, kaolin, borax, alum, salt, building stones, such as granite, sandstone, marble, etc. Also clays suitable for mineral paints, fire-clay, coal (poor quality), and cement.

Yet with all this wealth lying within her borders, the production of Los Angeles County, in any one of these materials, with the exception of petroleum, is insignificant. One cause for this may be found in the extremely rugged mountains and abrupt, deep cañons, and the dense growth of chemisal found on the hillsides, making it almost impossible to explore the country without hewing the way as you go. And further, the great lack of water in most places where there are any extensive beds of auriferous gravels.

In entering Los Angeles County by railroad from the north, we have on the east side the Mojave Desert, an arid scope of country covering between fifteen and twenty townships in the northeastern part of the county, comprising Townships 8, 7, 6, and part of 5 north, in Ranges 8, 9, 10, 11, 12 west.

This country is broken up in places by low ranges of hills, and covered mostly with a scattering growth of yucca, that was used by an English company as a raw material for the production of paper. For some reason the manufacture did not prove successful, and at present the factory is standing idle. This desert country has been prospected over to some extent, and reports are current of the presence of rich base silver ores, and also copper; further, deposits of clay and gypsum have been found a few miles back of Alpine, one of the stations on the Southern Pacific Railroad. The prospecting and working of these metalliferous veins is accompanied with so much hardship and expense, on account of the scarcity of wood and water and feed, that the mines have never been developed sufficiently to permit of any decided opinion being formed as to their true value.

On the western side of the railroad is Antelope Valley, which extends over to the Coast Range Mountains, coming in from Ventura and Kern, with a course north 60 degrees west and south 60 degrees east. This direction appears to be the line of upheaval which marks the northeast limit of the Coast Range along the line of the desert.

After leaving the desert and crossing the summit of the range, the road decends into the Soledad Pass and Cañon in a westerly direction, where Acton is located—a station on the Southern Pacific Railroad, and a dis-

tributing point for one of the few paying quartz mining districts in the county. The aneroid showed an elevation of two thousand two hundred feet.

CEDAR MINING DISTRICT.

The district known as the Cedar Mining District includes an area of about twelve miles square, comprising Township 5 north, Range 13 west; Township 4 north, Range 13 west, and Sections 5, 6, 7, 8, 17, 18, 19, 20, 29, 30, 31, 32, Township 4 north, Range 12 west; Sections 5, 6, 7, 8, 17, 18, 19, 20, 29, 30, 31, 32, Township 5 north, Range 12 west; Sections 29, 30, 31, 32, Township 6 north, Range 12 west; Sections 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, Township 6 north, Range 13 west; Sections 25, 26, 35, 36, Township 6 north, Range 14 west; Sections 1, 2, 11, 12, 13, 14, 23, 24, 25, 26, 35, 36, Township 5 north, Range 14 west; Sections 1, 2, 11, 12, 13, 14, 23, 24, 25, 26, 35, 36, Township 4 north, Range 14 west, of S. B. M. The principal mines in this district at the present time are the following:

Red Rover Mine.

This is in Section 23, Township 5 north, Range 13 west, at an elevation of three thousand three hundred feet, about three miles north from Acton. The vein strikes north 63 degrees west, and dips to the south about 82 degrees, with an average width of three feet. The walls, which are very good, are syenite for the hanging and slate for the foot wall.

The length of the ore shoot is given at two hundred and sixty feet. The mine is opened by both tunnel and shaft; the former is one hundred and forty feet in length and attains a vertical depth of fifty feet. The shaft is an incline about two hundred and eighteen feet deep.

The company use Hercules powder No. 1, and it requires about one pound of powder to every four tons of rock broken. The average cost of mining, per ton of ore, is from $2 50 to $3. The cost of tunneling, per foot of running tunnel, was $1 50 near the surface; now it amounts to from $4 to $5. The timbers cost laid down at the mine about $30 per thousand. They have to be shipped by rail from San Francisco or Los Angeles. The ore is gold quartz, free milling; it is conveyed to the mill on a tramway four hundred feet long.

The company has a ten-stamp mill with Dodge rockbreaker, a forty-horse power horizontal boiler and a twenty-horse power engine. The stamps weigh seven hundred and fifty pounds; they drop six and a half to seven inches, with ninety drops per minute. They have a capacity of twenty-four tons per twenty-four hours. The shoes and dies are steel and are the first set used. Up to date they have crushed one thousand two hundred and seventy tons, or one hundred and twenty-seven tons to the stamp; they will soon require changing, however. The screens used are No. 8 quarter inch, diagonal slot-punched, Russian iron; screens sixteen by forty-eight inches inside of frame, and placed vertical. The aprons are thirty-six to fifty-six inches, two to each battery. The sluices are fifteen inches wide and have a silver plate the full width of the sluice and twenty feet long, with an inclination of one and a half inches to the foot. They have two of the improved Hendy self-feeders, attached to the battery frame. The amount of gold saved is given at 80 per cent, of which about two thirds are retained in the mortar. The mortar contains two silver plates, the front one six inches by forty-eight inches, the back ten inches by forty-eight inches. The loss of quicksilver per ton of ore worked is about one pound to twenty-five tons of ore crushed.

There were at the time of my visit twelve men employed in the mine. This number since then has been largely increased. In the mill three men were at work, and three on the outside. Men in the mine were paid $3 per day; in the mill, $3 60, for fifteen hours work; outside men get $2 25. The mill consumes two and one half cords of wood per day, which costs $4 50 to $5 per cord; it is oak, juniper, and manzanita. The hoisting from a two hundred-foot shaft is being performed by a Baker whim, but a steam hoist will be erected in the near future.

The company experiences a drawback with the water that is at their disposal. They pipe their water through three miles of two-inch pipe into a reservoir, and then, after using it, they have to pump the water over into a tank above the mill after it has settled. This requires all the tailings from the mill to be shoveled over, and even then for a part of the season they can only run the mill for fifteen hours per day for lack of water. It is expected that this trouble caused by the lack of water will be got rid of on sinking the main working shaft to a depth of five hundred feet, which will take place very shortly. This company controls four full claims, known as the Red Rover, the John Logan, Earl, and Topeka. The Red Rover is the only one being worked at present. In the mine there are about two thousand tons of ore in sight, which will average about $10 per ton.

Altitude	3,000 feet.
Length of ore shoot	260 feet.
Length of ore shaft on incline	218 feet.
Depth of ore shaft vertically	About 200 feet.
Vertical depth reached in mine	200 feet.
Character of hanging wall	Syenite.
Character of foot wall	Slate.
Kind of powder used	Hercules No. 1.
Quantity of powder used	About 4 pounds per day.
Cost of mining	$2 50 to $3 per ton.
Cost of tunnel	$1 50 per foot.
Cost of shaft	$8 per foot.
Number of feet timbered	All of shaft (218 feet).
Kind of timber	Pine, square, 6x8 inches.
Cost of timber	$24 per M.
Length of ditch built	3 miles (2-inch pipe).
Character of ore	Auriferous quartz.
Character of works	Steam stamp mill.
Number of stamps	10.
Weight of stamps	750 pounds.
Drop of stamps	6½ to 7 inches.
Drops	90 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	No. 8, slot cut.
Dimensions of apron	36x48 inches (two to each battery).
Width of sluice	15 inches.
Length of sluice	20 feet.
Kind of feeder	Hendy.
Character of ore	Free milling.
Percentage of gold saved in battery	50.
Percentage of gold saved on plates	30.
Cost of milling	$2 per ton.
Number of men in mill	3.
Number of men in mine	12.
Total number employed	18.
Average wages in mine	$3 per day.
Average wages in mill	$3 60 per day (fifteen hours).
Average wages paid outside work	$2 25 per day.
Wood used per day	2½ cords in twenty-four hours.
Cost of wood	$4 50 to $5 per cord.

New York Mine.

This mine was relocated May 15, 1889. Years ago it was worked and is *said to have* averaged $30 a ton. It is situated about three miles north-

Acton. The vein courses northeast and southwest, and dips to the ɔout 75 degrees; it has an average width of four feet. It is opened everal tunnels; the principal working tunnel is about eight hundred ʒ, and reaches a vertical depth of three hundred and twenty feet. he level of this tunnel is an incline shaft one hundred feet deep. ls are syenite, with a casing of chloritic slate. They use about fifty of Giant powder No. 1 and No. 2 per month, and the cost of mining imate at $3 25 per ton of ore. In running the tunnel they passed porphyry, syenite, and slate. In this mine they use Oregon pine ɔering, which costs them 4 cents per foot laid down at the mine. ı some timber about twenty miles from the mine.

nill is about two miles from the mine; the ore is hauled by the t a cost of 50 cents per ton. The ore is similiar to the Red Rover; shed in a five-stamp steam mill and amalgamated in the battery plates. The stamps weigh seven hundred and fifty pounds, drop ıes, and make ninety drops per minute; they have a duty of two ɔ fifths tons per stamp. The shoes and dies are of white iron, and cents per pound laid down at the mine. The shoes and dies have four hundred and fifty tons. In this mill they use patent brass-eens, No. 55 to 60. The apron is four feet long, and there are twelve luices with copper plates one foot wide and set at an inclination of vo inches to the foot. The feeder is home-made. They claim to out 50 per cent on the plates and 50 per cent in the battery, and of quicksilver is about one pound to every ten tons of ore. A Tri-oncentrator has been bought, but has not been put in operation yet. ıumber of men usually employed at the mine is sixteen, but at the time they are only doing some prospect work, so that there are only ıen at work. The mill employs four men, and one man works on side. The average wages are $3 for miners, $2 50 for mill men, 50 for outside work. The wood costs, delivered, $5 per cord, juni-oak, and the mill consumes two and one half cords per day. Like Rover Mine, the water supply is a weak point in the plant. It has present owner, Mr. O'Riley, $3,500 to obtain the necessary water, ner's inches under a six-inch pressure, and it has cost $2,000 to lay ɔusand two hundred feet of two-inch pipe to bring the water to the

	About 3,000 feet.
f ore shoot	500 feet.
f ore shaft on incline	100 feet.
ore shaft vertically	About 87 feet.
r of hanging wall	Slate.
r of foot wall	Syenite.
powder used	Giant No. 1 and No. 2.
of powder used	At present, 50 pounds; with full force, 200 pounds per month.
ıining	$3 25 per ton.
ınnel	$6 per foot.
ıaft	$8 per foot.
of feet timbered	No record; the amount small.
imber	Pine.
mber	4 cents per foot.
f road built	Two miles.
f ditch built	4,200 feet of 2-inch pipe line.
ransport of ore	50 cents per ton.
r of ore	Quartz, with free gold and a small percentage of iron sulphides.
r of works	5-stamp steam mill.
of stamps	5.
f stamps	750 pounds.
stamps	6 inches.
	90 per minute.
stamps	2⅖ tons per stamp in twenty-four hours.
shoes and dies	White iron.

Size and character of screens	Patent brass wire from 55 to 60 meshes.
Water used in battery	⅜ inch.
Dimensions of apron	4 feet.
Width of sluice	12 inches.
Length of sluice	12 feet.
Kind of feeder	Home-made.
Kind of concentrator	Triumph.
Percentage of gold saved in battery	50.
Percentage of gold saved on plates	50.
Cost of milling	About $2 per ton.
Number of men in mill	4.
Number of men in mine	3.
Total number employed	8.
Average wages in mine	$3 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$1 50 per day.
Wood used	2½ cords per day.
Cost of wood	$5 per cord.
Quantity of water used in milling	⅜ to 1 inch.

No ore is being crushed at present, as the mine is being prospected to open out a body of quartz supposed to be below the present stopes. At the present depth of working the quartz is of a low grade, not over $7 per ton. The quartz seems to form in swells, and then on a short distance to spread out into a number of feeders penetrating both walls, the walls at such times showing a mineralized condition, containing bunches of iron sulphides, but unaccompanied by gold. The present property consists of three full claims. Near the surface the vein seems to have run in three feeders, averaging about one foot each, and being about two feet apart. Two of these were of good grade, and could be distinguished readily by showing a rust stain in the quartz. The third was of a lower grade. On following them down they all united and formed a body of quartz of from five and a half to seven feet thick. At a depth of about one hundred and twenty feet the vein again consists of a number of seams, none of them over eight inches in width. The gold is of a coarse order, easily amalgamated, and is valued at from $14 to $15 per ounce.

All the quartz in these two mines is of a glassy nature, with occasional streaks of a greenish cast running through it, not copper stain, and showing splashes of iron pyrites. Streaks of calcite are met with in the walls of the vein at no great distance from the quartz. The whole country around here seems to have been mineralized through porphyry dikes that crop out in different places, rather prominently in a northwest and southeast course. A great drawback to these properties is the lack of abundance of water.

Between Acton and the next station below, Ravenna, in the same mining district, are a group of copper mines that have had considerable money and labor expended on them, but on account of the present condition of the copper market are lying idle.

The Emma Consolidated Mining Company.

This property consists of the following ledges: The Emma ledge, four feet wide, ranging to the northeast and southwest, and dipping to the east very slightly, containing silver and copper in quartz. A shaft has been sunk to a depth of seventy-five feet, and a tunnel run in five hundred feet, but will have to be continued another one hundred feet to strike the vein, which it will do at a vertical depth of four hundred feet. The tunnel is six by eight feet with an air shaft. Wood and water are plenty in the vicinity of the mine. The Bullion is situated on the same hill, and in close proximity to the Emma. It runs parallel with the Emma, and dips towards it.

ge can be seen in a deep cutting with a width of eight feet. The ies gold, silver, and copper.

'acific is the extension of the Bullion on the same vein. The Lon-sses the other two veins, running almost east and west. They are l claims, and were located in 1888, but had been worked years ago ench syndicate. The Pacific has a shaft forty feet deep, showing lefined six-foot ledge containing gold, silver, and copper ores. The ledge is about three feet wide, containing copper and silver. It has ne shaft seventy-five feet deep, and a tunnel one hundred feet long, vill ultimately tap the ledge at a depth of about three hundred feet. s are carbonates and sulphides in quartz; the country rock is gran-ie value of the Bullion and Pacific ores, from tests made, is $4 in d $15 in silver.

Emma vein contains 15 per cent copper and 15 ounces silver. illion and Pacific dip to the west; the Emma to the east, and the to the south. About two miles and one half south of Acton, close ailroad and at an altitude of two thousand two hundred feet, is a iat was sunk to a depth of thirty-five or forty feet on a strong vein r and silver ore; but at that depth the parties sinking encountered i water that they abandoned the property. From Acton, down the South Side and Lang's Station, the metamorphic rocks are promi-ranitic rocks with dioritic dikes, then again decomposed green-and breccia of green and red porphyry.

le beyond Ravenna, on Section 15, Township 4 north, Range 13 it far from the road, is a stratum of magnesia, pitching to the west hill at an angle of 30 degrees, and back of that a very bold, pro-l range of red sandstone and conglomerate, extending quite a dis-vith a northwesterly trend, and dipping to the west at an angle of 0 degrees. Underlying this is a heavy body of granitic rock, with greenstone cutting through. After passing down the road from Side we find issuing from the metamorphic rock several sulphur some of which are being used for medicinal purposes. Below and f Lang's Station about two miles is a large deposit of gypsum, ight feet wide, almost perpendicular, in Section 30, Township 5 Range 14 west, S. B. M. After passing Lang's Station the cañon out, the main metamorphic range stands back, and some very fine es of clays and sandstones and shales show themselves, dipping but

Mount Gleason Mines.

t four miles east and south of Acton, on the opposite side of the iñon, rises the Gleason Mountain to an altitude of six thousand five d feet. It is a prominent spur of the main range, occupying Sec-, 26, 35, 36, Township 4 north, Range 13 west, S. B. M. It is a structure with micaceous clay slates. On this mountain there are quartz veins coursing northwest and southeast, and dipping to the st at an angle of about 80 degrees, and on these considerable work performed at the present time. The mountain is partly timbered rly well watered. A good mountain road leads half way up the in; from there mules have to be used for hauling.

principal mines are the Padre Mine, the Mount Gleason Gold Mine, ly Bros.' Mine, the Peerless, and a group of claims known as the rande Mines. The latter claims consist of the Gold Bullion, the in, the Veteran, the Golden Rule, and the Old Town. These claims tiguous to one another, being extensions of one vein, with the excep-

tion of the Gold Bullion. The vein courses north 35 degrees west, and forms the apex of one of the ridges running from the main spur down about one thousand five hundred feet into a cañon that has its drainage into the Tujunga Cañon. The vein averages something over two feet in width. The quartz from the surface shows considerable rust stain, and is honeycombed. A mill test of this ore gave $12 per ton in gold. Another vein coming down the highest ridge has a course of north 50 degrees west. A third vein coursing similarly shows at present the most exposures and workings. Of these mines the oldest is the Padre Mine, with a shaft eighty-one feet deep, situated one hundred feet east of location notice, with a three-foot vein in the bottom of the shaft. The ore from this mine pays from $8 to $12 per ton by common mill process. One hundred feet east of this shaft is another shaft forty feet deep, with a five-foot vein paying $16 per ton; also a drift eighteen feet long. This vein shows very bold, prominent croppings. The immediate contact walls with the quartz are micaceous clay schist, but the country rock is granitic. A peculiarity in the contact of the walls is, instead of having a clay gouge solely, there is a distinct division caused by an accumulation of particles of mica to the thickness of half an inch in places.

Adjoining the Padre Mine, which was not being worked the day I was there, is the Mount Gleason Gold Mining and Milling Company's property. They have a tunnel one hundred and forty-five feet long, eighty feet of which is run on the course of the vein, exposing a vein from three feet wide at the commencement to eight feet wide at the end of the tunnel, which is eighty feet perpendicular beneath the surface. This company has about two hundred tons of ore on the dump that they claim will average about $16 per ton by actual working test. The quartz is honeycombed, showing native sulphur in some of the cavities; also free gold in a finely powdered condition. At the present time, a five-stamp steam mill is in course of erection. This company claims two locations—the *Last Chance* and the *Eagle*—one of which is in dispute. The next extension to the southeast is the Kelly Bros.' claim. They have three tunnels—one fifteen feet, one forty-seven feet, and the third sixty feet in length—running in on the vein on different sides of the cañon that the vein crosses over.

In this claim the vein mass shows a very pronounced sulphide character, pieces of solid iron sulphurets being found as large as a man's head. This company is putting up a two-stamp steam mill, and have quite a large amount of ore out ready to crush, but the ore looks rather unsuitable for a simple battery amalgamation process. At the east end of this claim, a cut, six feet long, five feet deep, exposes the ledge three feet wide. The east extension of this claim is the Peerless, lately taken up, and not showing any great development, a short drift having been run to the vein and some surface exposures made. The drift is twenty feet long, and shows the ledge to be two feet wide. At the west end of the claim, the vein appears to be broken up; at the east end, it shows solid, and about one and one half feet wide.

Passing up the Soledad Cañon about four miles we find the mouth of the Aliso Cañon, which winds around to the east of the base of Mount Gleason, through a mesa composed of metamorphic drift and wash, and which has been cut down and exposed in places to the depth of fifty feet, at the same time laying bare, in places, the granitic flanks of the spurs of the main ridge. All of this wash is auriferous, but not in sufficient amount to pay with the amount of water on hand. Finally, after attaining an altitude of four thousand six hundred feet, we reach the top of a narrow divide separating the watersheds of Aliso and Tujunga Cañons. The for-

ation continues unbroken granitic, with large crystals of feldspar and casional dikes of diorite.

The road now descends into the North Fork of the Tujunga a distance five or six miles, when we once more meet with evidences of quartz ining. A tunnel leads into the hillside at the road level a distance of bout one hundred and fifty feet; the back end being filled with water, we ould not ascertain the length. About forty feet from the entrance is an cline shaft about twenty-five feet deep, but we could not find any vein. n the opposite side of the road were three steam arrastras, but the engine ad been removed and the whole bore a deserted appearance.

TUJUNGA MINING DISTRICT.

About seven miles from the Divide we reach the Tujunga Mining Disrict, and find the following mines:

Josephine Mine.

The Josephine Mine, at an altitude of four thousand feet, has one tunnel bout one hundred and fifty feet long, about sixty feet under the surface ertically, showing a three-foot vein coursing north 10 degrees east and outh 10 degrees west, dipping almost perpendicular. Below this is another unnel between three and four hundred feet long, with the vein four feet ride; here the dip has changed to about 50 degrees to the east. Between he lower tunnel and the surface the ground is nearly all stoped out. In onnection with this mine is a small four-stamp steam mill and a five-foot Iuntington centrifugal mill. The stamps weigh four hundred and fifty ounds; the duty of the mill is about half a ton to the stamp. Neither ine nor mill was running, but the mill was being fixed up to make ome working tests on ores from neighboring mines.

Parties living in this camp claim that the ore cannot be successfully orked here; that ore sent to San Francisco gave high returns in gold, hile the same ore worked in the mill here hardly yielded expenses. As e ore is for the most part a honeycombed quartz, with iron sulphides, nd yields its gold readily in the horn spoon, and the gold is readily bsorbed when brought in contact with quicksilver, the trouble must be in e manipulating. The idea was that the water contained some substance eleterious to amalgamation, but as far as taste or smell could discern, I iled to notice anything unusual in the water; there was certainly no vidence of oil.

Besides the Josephine, there are the Tujunga claim, the London, the [ope, which are all extensions of the same vein, and have more or less rface work done on them, in the shape of uncovering the vein along its tcrop. In close proximity to this claim is the Lottie, at an altitude of ur thousand three hundred feet. This ledge strikes 32 degrees east of orth and west of south, and dips to the west at an angle of 50 degrees.

The vein averages about one foot in width and shows, near the surface, onsiderable decomposed quartz that prospects very high. An incline shaft down on the vein about forty feet, and a small side drift is run from it bout twelve feet. A little beyond the incline is a drift about sixty feet ng, which shows the vein in the end about one foot wide; besides this, ere are several small cuts and prospect holes along the line of the vein.

The extension of this vein to the north belongs to a group of veins owned y Los Angeles parties, the principal claim of which is the Pacific, where everal men are at work. This is on the highest part of this spur, at an

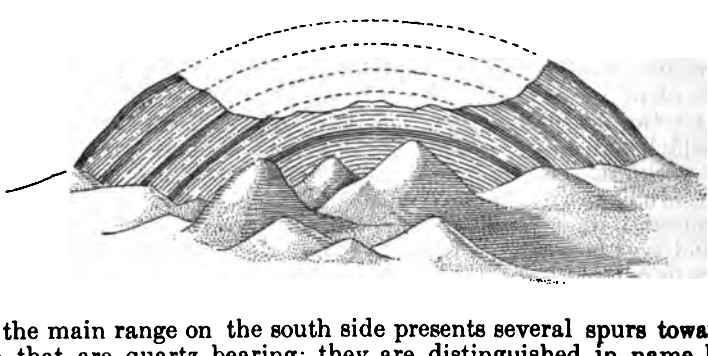
elevation of five thousand nine hundred feet. The work done here consis of a sixty-foot drift, showing in the end a two-foot vein, striking east an west, dipping 82 degrees to the north, and stoped from the tunnel level t the surface, a distance of thirty feet. At the end of the drift is a perpen dicular shaft, fifty feet deep, eight by five feet from the bottom. A drift ha been started, which is in about twenty feet, and shows a vein two feet wide between walls, with about ten inches of quartz.

The country rock is granite with large crystals of a bluish feldspar They are taking out ore here for a test run to be made in the mill belonging to the Josephine claim. Across a gulch from here, to the east, on another spur, a claim was taken up called the Dundee, and two shafts sunk and a drift run, but without any results. All of these mines show the same quality of quartz, honeycombed, rust-stained near the surface, white and glassy, with undecomposed iron sulphides below. Another claim belonging in this group is the Cable, which has a tunnel forty feet long, striking a ledge bearing north 10 degrees west, and dipping 80 degrees east. The end of the tunnel is about sixty feet underground. One man was at work here Near the mouth of the tunnel is an incline shaft sunk on the vein to a depth of twenty feet, showing four feet between walls.

Passing northwest from the Tujunga camp over a trail, about one mil distant, at an altitude of four thousand six hundred feet, is "the Moos claim," with a foot wide vein coursing 35 degrees northwest and southeast and dipping to the east under an angle of 45 degrees. The walls are granite But little work has been done. In passing down the Tujunga Cañon, vein of specular iron can be seen; also, about seven miles from the mines, a granite with extremely coarse flakes of mica, some of them being one and one half inches square. In the main Tujunga Cañon, two or three partie of Americans are working with dry washers, with varying success.

After reaching Kent's Station, where the Soledad Cañon broadens, we have in the foreground a range of low-lying hills of clay and sandstone and gravel, showing some very distinct exposures; one in especial show the distinct stratification of different colored clays, and then a later denuda tion of the top with a redepositing at a short distance in front. Back o

Nº 1



these the main range on the south side presents several spurs toward the cañon that are quartz bearing; they are distinguished in name by the cañons lying between them, and which have been called the Blacksand Cañon, the Bear Cañon, and the Arrastra Cañon. Where the first two o these cañons debouch into the flat, some prospectors found and showed me some pieces of float telluride of gold, which we tested in an assay office in *Newhall afterwards*, but up to the present time I have not heard of its hav

ing been found in place. These cañons have a general southeast and northwest direction, and are extremely narrow and rugged. The ranges that divide them consist of granitic rocks, porphyries, and micaceous clay schists; but they are so completely covered with a heavy growth of chemisal as to make explorations extremely tedious.

As in all the cañons of this country, the small streams found in them become raging torrents for a short time after every rain, and bring large quantities of debris off the main ranges, accumulating the wash at the mouth and in the cañon. Most of this wash is auriferous, but not sufficiently so to encourage any one with the small amount of water on hand to work it.

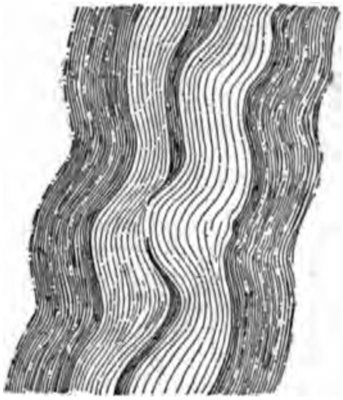
The first quartz vein we encounter is near the mouth of Bear Cañon. It has a strike of 16 degrees east of north, dipping to the west about 53 degrees, with a width of about eighteen inches, and with clay-slate walls. It is known as the Providence Ledge; has had a little work done on it, but is at present abandoned. About two miles further up the creek there is another quartz vein crossing the range between Arrastra Cañon and Bear Cañon, and continuing through the range that divides the latter from the Blacksand Cañon, with an east southeast and west northwest strike, and dipping to the south. Here a mining district has been formed in Sections 35 and 36, Township 4 north, Range 15 west, S. B. M., known as the St. George Mining District, recorder Mr. G. Rehbert, who is also the owner of the principal claim, as far as developments are concerned. Through him we obtain the following information:

There are at present in the district three claims that are being prospected, while a large portion of the country has been staked off by claimants, who merely do assessment work and wait for somebody to buy them out. The three main prospects are known as the Star of the East, the Star of the West, and the Evening Star. All these claims are situated on the same vein, coursing east southeast and west northwest, cutting through the dividing ridges at an acute angle. The vein dips to the south at an angle of about 45 degrees, and has an average width of twenty inches. The walls are clay-slate and porphyry. The ore will average about $16 per ton. The Star of the West employs part of the season two men at $2 50 per day. The developments consist of two tunnels running on the vein from Bear Cañon, one on each side of the cañon, at an altitude of two thousand and twenty feet; these are twenty-five and twenty feet long, respectively. The ore has been worked in a horse arrastra eight feet in diameter, situated about half a mile above the tunnels in the cañon, and yields on an average about $25 per ton. The gold is very coarse, some pieces found being worth $1 25. This claim controls a water-right at the head of the cañon, with about four miner's inches of water under a six-inch head.

The Star of the East lies mostly in Blacksand Cañon. The sides of the cañon are extremely precipitous and covered with chemisal, making prospecting extremely difficult. Other quartz veins are said to exist higher up, as float is found among the debris washed from the main range which carries a large percentage of silver. A very great amount of the wash in the cañon consists of a micaceous ironstone. A very interesting geological feature is seen on an exposure of the quartz vein in Bear Cañon, which would seem to clearly demonstrate its metamorphic origin; the vein matter shows here not only a banded or stratified face, but these strata show that they have evidently been distorted.

In passing from here back to Kent Station, and from thence to Newhall, a person cannot help being struck with the very large bodies of wash and

FIG. 2.
Quartz Exposure in Bear Cañon



gravel that present themselves, all auriferous to some extent, but which lack the necessary amount of water for their profitable conversion.

Newhall, a small town and station on the Southern Pacific Railroad, is the shipping point for the Pacific Oil Company's wells around Pico Cañon and adjacent points. It is about twenty miles north of Los Angeles and immediately north of the San Fernando Range. It has two creeks in close proximity that empty into the Santa Clara through Pico Creek, but are nothing more than dry river-beds through the greater part of the season.

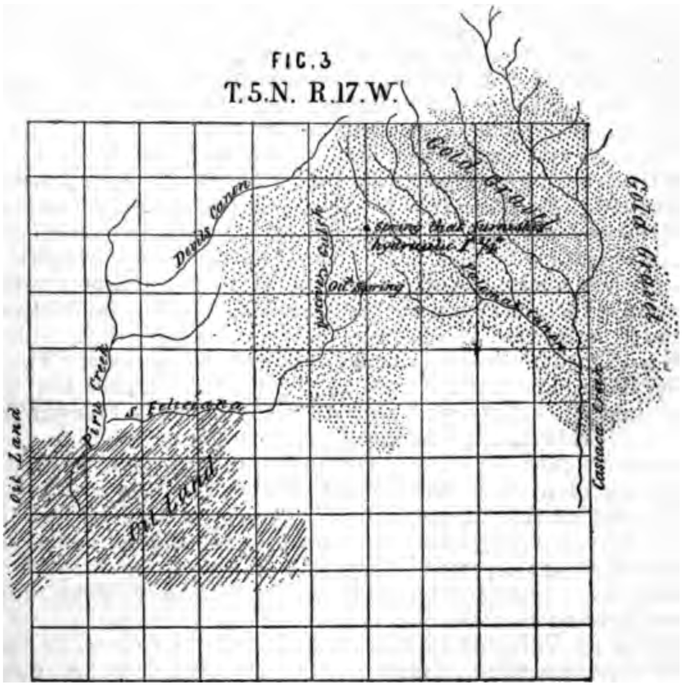
Running northwest and southeast are a low range of hills of tertiary, sedimentary formation, between which the Placerito winds, forming a cañon, in which, in some places, gravel mining has been carried on by hydraulic process, and also by drift and with the rocker. These hills are entirely composed of gravels, clays, shales, sandstones, dipping to the north at a very small angle. On the bars in the cañon there are spots that yield an appreciable amount of washed gold, the source of which seems to lie beyond the head of Placerito Cañon, in the metamorphic rocks, of the main San Fernando Range. A Los Angeles company has lately bought an extent of placer ground here, and are trying to hydraulic it with water raised out of a thirty-foot shaft by steam power. The ground is said to be rich. It was bought for $15,000. About four miles up the cañon the creek forks. The main fork, on the south side, enters between metamorphic rocks and meanders in a southeasterly direction. Some good exposures can be observed here.

The bluffs show a granitic, or more correctly, a syenitic and gneissoid structure. They rise to an elevation of one thousand seven hundred feet above the sea. Their original sedimentary and plastic condition can be very distinctly observed, showing an arrangement of the mica particles that gives a very perfect cleavage, also showing remains of foldings and contortions, and from that on through to rock, where all structural formation is obliterated. Bearing more to the east, about four miles from the forks, we find a vein of limestone, white and crystalline, between two varieties of syenite, the one of which shows very large, distinct crystals of hornblende; the other approaches nearer the character of a true granite. The limestone trends to the north 60 degrees west; it is in Section 5, Township 3 north, Range 15 west, S. B. M., and dips almost perpendicular. All

along this part of the cañon evidences of placer work are seen, and on inquiry we found that the Chinese work here during the wet season. About one mile further up the cañon from the limestone ledge we reach the head of the main Placerito Cañon; it runs out into several small cañons reaching up onto the main range, and among the low hills of sand and gravel deposited on the flank of the main range, and furnishing the material for the present work of denudation which is progressing here so visibly.

On the main range between the head of Placerito Cañon and Bear Cañon are several graphite veins, but not of a grade to pay for working them.

AURIFEROUS GRAVELS OF CASTACA, PALAMOS, AND SAN FELICIANA CAÑONS.



Going in a northeasterly direction from Newhall, at the crossing of the Santa Clara River, we enter the mouth of Castaca Cañon, with a creek of the same name. Following this creek about six miles, we reach some extensive deposits of auriferous gravel, where the Palamos Creek enters into Castaca Creek from the west side (Fig. 3). Going up through Palamos Creek into San Feliciana Cañon, we find some parties working these gravels, with the help of Chinese, in what is known as the east part of Palamos Mining District. They worked with a small hydraulic, collecting water from a spring yielding one and one fourth miner's inches. This is gathered in a reservoir that permits of the use of the pipe, through a two-inch nozzle, for two hours and a half a day. The altitude of these diggings is two thousand four hundred feet; the area, roughly estimated, is eight miles by four miles in extent, but the whole of it is considerably cut up by gulches and cañons. The gold is in the nature of sheet gold. The bedrock of this cañon is mostly conglomerate, though clay-slates and

shales are also to be found; in fact, the gravel here overlies the sedimentary formations, in which the oil measures are found.

This gravel deposit furnishes some interesting studies as to its formation. Fossil remains of deer and mammoth have been found the past season, consisting of the thigh bone of a mammoth, also a tusk. The former is now in the possession of a gentleman in Los Angeles; part of the joint was forwarded to the Bureau. The tusk fell to pieces as soon as it was exposed to the air. Besides this, prints of bird tracks were found in the bedrock, evidently waders. These had been destroyed, as of no value, in the course of picking up the bedrock. If we consider these facts in connection with the very irregular, uneven bedrock, it would seem to point to the fact that the water was not confined to the narrow bed of a stream in which this gravel was deposited, but spread out, with little current and shallow banks, that permitted a heavy growth of water grasses, the home of numerous insects and worms, thus attracting both the animals and birds, while the marine shells in the near surroundings would point to an inlet of the sea or a bayou of brackish water.

The shape of the gold found would also be more likely to be produced by the scouring motion of the tides than by the rolling motion of a running stream. Furthermore the richest part of the gravel is not exclusively on the bedrock, but in streaks in the gravel, that can be plainly distinguished by a heavy rust action. These lie in places considerably above the bedrock, and sometimes above one another. The accounts of the yield of this gravel, which has been worked years ago, are very conflicting. The Mexicans formerly are said to have taken out large sums, which their extensive workings in some places would seem to corroborate. The present workers on the ground put the yield, per square yard, rather low, but even at their figures if, as is thought possible, water could be brought from the Piru Creek, all this immense scope of gravel could be made to pay something handsome over expenses. The height of the gravel is hard to estimate, it having been cut out so much; it has been given as averaging ninety feet, but I consider that rather high. Between these gravel hills and the Castaca Cañon is a range of hills composed mostly of sandstones and cemented conglomerates, crowned beyond by a range of metamorphic rocks, which show some quartz veins that have been prospected by tunnel, but are now entirely abandoned.

In passing up Palamos Creek into San Feliciana Cañon, I noticed a deposit of very fine, white, quartz sand, that seemed to be suitable for glass-making purposes. At the head of Spring Cañon, near Palamos Cañon, float quartz is said to have been found of great richness, but no explorations have been made.

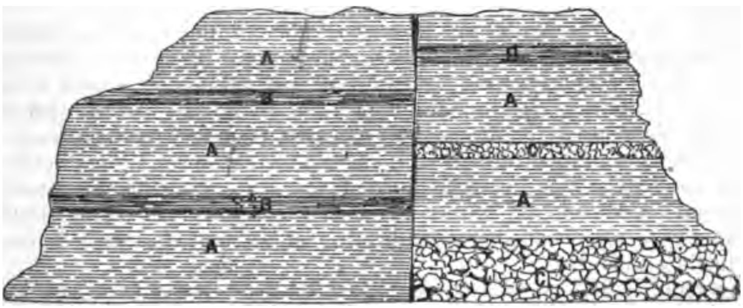
Crossing Castaca Cañon, opposite the mouth of Palamos, and taking up over the hills in a northeasterly direction, we again find a large area of auriferous gravel on the other side of Charles Cañon, that has been taken up by a New York company. Their ground comprises an area of nine thousand acres, extending up both sides of the Cañon El Dura. To work this ground with hydraulic process—the only way it can be advantageously disposed of—requires the bringing in of a ditch from Elizabeth Lakes, a distance of four miles, by which they will obtain a large fall. The gravel differs from the San Feliciana in that it is harder—more cemented with iron. The bedrock, where seen, is sandstone; the gravel is not as smoothly washed as the other. A good deal of work has been done in these cañons by Mexicans and Americans with the pan and rocker. The gravel is about six or eight feet thick in the cañons. The gold is not so coarse as

in the San Feliciana Cañon. In the Charles Cañon evidences of bituminous sandstone are visible, but not to any extent.

A third company has been organized under the name of the Nevada Gold Mining Company, who claim three thousand five hundred acres between Elizabeth Lake and the Castaca Junction. They hold a water right of one thousand miner's inches out of the Castaca Creek.

About four miles up Castaca Creek from the entrance of Palamos the cañon is bounded on both sides by shales and sandstones dipping at an angle of about 30 or 35 degrees, and interstratified with very thin strata of carbonaceous matter almost entirely of the nature of charcoal, being in places quite feathery. Here some parties have put down two shafts, one on each side of the cañon, nearly one hundred feet deep, with the idea of striking coal in paying quantities; both shafts encountered so much water that operations had to cease until pumping machinery could be obtained. In the hills back of the cañon on the northeast side there is a large deposit of calcareous sandstone, with large oyster shells embedded; this sandstone is in places interstratified with thin layers of gypsum. The main Castaca Cañon here is about two hundred yards wide. The ranges on both sides, rising about four hundred feet above the cañon, are regularly stratified, the general course being northwest and southeast, and dipping to the west. Continuing up the cañon a distance of five miles we have a very distinct exposure of the formation, sandstones, shales, and conglomerates, dipping conformably, showing in some parts local disturbances, and one very distinct faulting, as shown in the accompanying sketch:

FIG. 4.



A *Sandstone* B *Shale*
C *Conglomerate*

Turning to the east and leaving the cañon, after crossing a divide at an altitude of seven hundred feet, over a precipitous trail, we strike once more the porphyritic and granitic rocks. At first we find a porphyritic dike about three miles wide and six miles long, with a general east and west trend, with granite on the north and sandstone to the south. In this porphyritic belt several quartz veins are found.

The whole ridge is known as Silver Mountain, and constitutes the main part of the mining district of the same name.

SILVER MOUNTAIN MINING DISTRICT.

The principal prospect is known as the Silver Mountain Mine, situated at an altitude of two thousand eight hundred feet, and owned by Colonel

De Freese and Barrett. Two further claims on the same ledge are owned by Messrs. Kelsey & Thomson; their mine is about one hundred feet higher than the first, and yet another one hundred feet of elevation brings us to a third claim; these last two claims are to the northeast of the Silver Mountain Mine.

The Silver Mountain Mine was being worked under a six months' bond. The parties working had just forwarded one thousand pounds of the ore to San Francisco to be worked as a test. I have since heard that the returns were lower than expected—$8 22. The ore is a sulphide (galena and iron pyrites) and the whole thing seems to be more in the nature of an ore pipe. Several openings have been made, both by tunnels and inclines, yet not sufficient to prove the extent of the ore shoot. In the other two locations we found one tunnel one hundred and twenty-five feet in length, but at the time of our visit no work was being done, nor was any one around the place. About a quarter of a mile northeast of here there is a quartz location with three tunnels; the lowest shows a body of sulphide ore, fifteen feet wide, over two hundred and fifty feet vertically beneath the surface, striking southeast and northwest and dipping about 70 degrees to the north.

Returning to the main Castaca Cañon and continuing up the creek three miles further, through sandstones and conglomerates, we reach the mouth of the Little Castaca Creek. This, like the main creek, gives opportunity to study some fine exposures of sandstones and conglomerates. At a distance of two miles beyond the mouth, traveling easterly, we come upon a large belt of limestone several miles long, ranging east of north, west of south, about one hundred yards wide. This limestone is bordered on the north by granite. Some prospecting has been done here and ore said to contain silver found. Specimens found showed iron sulphides.

Parallel with this limestone is a quartz location known as the Great West, striking 15 degrees east of north, dipping 47 degrees to the west, at an altitude of two thousand four hundred feet. The ore is said to assay $28 per ton in silver. In this vein a layer of mountain leather (asbestos) was found next to one wall. Several prospect cuts and tunnels have been started, but no regular mining developments. Where the limestone breaks over the top of the hill fine specimens of aragonite showing the concentric ring formation were found, also specimens of calcite. Overlying the limestone is a calcareous sandstone containing shells, but mostly in a crushed and mutilated condition.

In continuing still further up the main Castaca, the cañon goes by the name of Salt Creek, from the salt pools that are found near its head, filled with salt in a mushy condition. In several places in the cañon and in some of the smaller side cañons the clay slates and shales show a white efflorescence which has a sweetish, puckering taste, presumably alum. About one and a half miles southwest from Newhall, in some low-lying sandstone hills, a Mr. Brophy is mining for coal. He has started an incline drift on one of the larger bituminous strata, on the same dip as the strata have, 25 degrees north. The strike is east and west. This stratum in the end of the drift is thirty-two inches thick, and above it is a layer of thirty inches of fire-clay. The roof is ferruginous sandstone, containing strata of shells in places. Toward the bottom of the drift the carbonaceous matter becomes more compact, assuming in places the appearance of lignite. They say they have had it tested and it contains 72 per cent carbonaceous matter and 26 per cent ash.

As the oil wells of the Pacific Oil Company and the California Star Oil Company have been visited and discussed both by Professor Goodyear, *E.M., and* Mr. Silver and others, in previous reports of the State Mining

Bureau, I will merely refer to them, to note that a very interesting experiment has been in course of progress during the past season. At Well No. 19 of the Star Oil Company they are putting down a well for the first time in California with the diamond drill. At the time of my visit they had obtained a depth of over four hundred feet (at the present writing they are down eight hundred feet, and will soon commence pumping). As compared with the old style of drilling, the advantage they expect to derive lies in being able to tell exactly the nature, thickness, and inclination of the strata they pass through. Another advantage is gained by always having a perfectly straight hole, thus saving the time required sometimes in the other method in rimming out a crooked hole.

As the tool does not get stuck in the hole, there is no time spent fishing for lost drills. The speed in putting the hole down is not as great as with the old style, and in soft, putty-like ground it does not seem to work at all, as the diamonds become clogged, shutting off the water. Up to the present time they have averaged about a foot an hour when drilling, a much slower progress than is made in the old style of drilling. The principal objection among practical oil men to the diamond drill is that it necessitates the constant presence of water in the hole, which presses back the oil. During my presence at Well No. 19 some interesting specimens of the core were obtained, containing very perfect shells, in the oil-sand strata. Since last year the company has five new wells down. The production is about the same—in the neighborhood of four hundred barrels per day. They find that their productive ground extends a good deal further east than they had expected, and they have just erected the plant to sink a well on this new ground, which will be designated as Elsmere No. 1.

The California production of oil is a matter of vast importance to the State, and is yet only in its infancy. A thorough study of the oil measures as to their thickness, regularity, and occurrence would be of great lasting benefit to the County of Los Angeles especially, as it is by far its most important mineral production. This is the more to be desired, as the oil measures in Pennsylvania and the Eastern States being different—more simple, in fact—are not a sufficient guide for the complex conditions found on this coast. A special geological map of the oil lands of Southern California, though hard to execute on account of the extreme ruggedness of the country in part, would repay the cost and labor expended on it manifold.

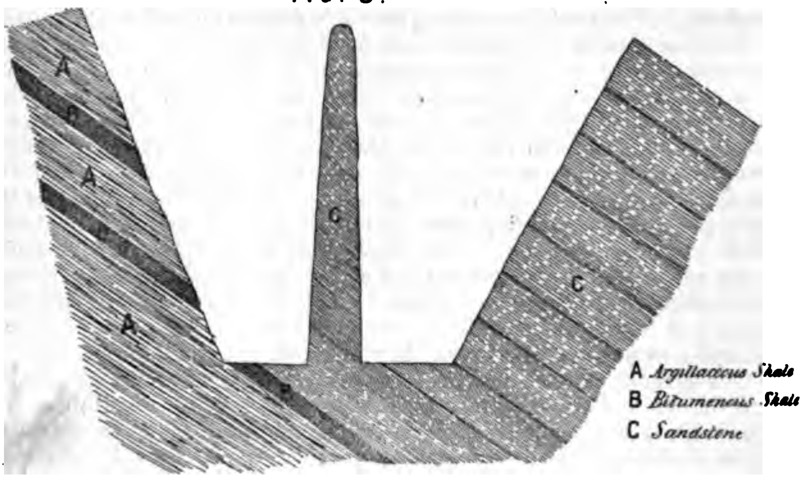
The California production of oil has not reduced the importation of illuminating oils, as up to the present time the eastern oil has been found more fitting for that purpose; but experiments looking in that direction are being all the time made, and some very good samples of illuminating oil have been produced. The main trouble seems to be too large a percentage of the heavy hydrocarbons, causing it to smoke when exposed to drafts. California oils are mostly used for fuel and as lubricants, and in the latter capacity they have almost entirely replaced the importation of foreign oils.

The eastern part of the California Star Oil Company's ground, where they are now starting the Elsmere Well No. 1, can be very thoroughly examined through a small cañon that enters near the San Fernando road about two miles south of Newhall, and which continues to the divide of the San Fernando Range, not far from where Grapevine Cañon heads, on the south side of the range. In the debris of this cañon we meet with granites, argillaceous shales, oil sandstones, bituminous and fossiliferous sandstones, bituminous shales, and asphalts and porphyries. The sandstone bluffs that mostly form the walls of the cañon, are in part heavy-

bedded, striking to the north and south and dipping about 58 degrees to the west. In these sandstones, toward the lower strata more especially, we find remains of helix, ostræa, spirifer, and other shells. This sandstone seems to overlie the argillaceous shale, which is traversed by bands of bituminous shale, from which, in numerous places, the bitumen exudes and gathers in pools on the bottom of the cañon.

In several waterholes in the course of the cañon evidences of the presence of oil were distinctly perceptible. The water here was alkaline, and the shale in several places bore a white efflorescence. After passing up the cañon quite a distance it contracts until it is not over six feet wide.

FIG. 5.

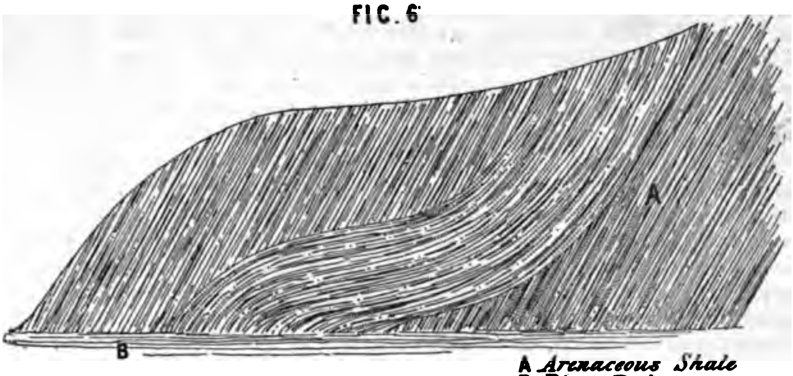


and is here divided by a narrow wall of sandstone, as seen in the section in Fig. 5. On both sides of this dividing wall, as also on the left hand wall of the cañon, are, at irregular intervals, about four feet above the bottom of the cañon, nodules of sandstone imbedded, about one or one and a half feet in diameter, looking as if carried up and lodged by a tide. The aneroid showed here an altitude of one thousand four hundred feet. About half a mile beyond this divide we find a large amount of shell remains. The top of all these strata on the main divide is capped over with a very dark limestone.

LOS ANGELES CITY.

The City of Los Angeles is situated in a valley of the same name, which extends from the ocean back in an easterly direction about thirty miles, gradually sloping up from sea level to an altitude of one thousand five hundred feet. The low-lying hills in the immediate neighborhood of the city are unaltered clay shales and sandstones, striking northeast and southwest, with a dip of about 50 degrees southeast, occasionally interstratified with thin layers of gypsum and lime. Some of the exposures in these bluffs are very distinct and interesting, as the accompanying figure (Fig. 6), taken from a bluff beyond the old depot on the road to Verdugo, shows. In several localities in and about the city, wells for oil and gas have been bored. About nine miles from the town to the north, in what is known as

FIG. 6



A *Arenaceous Shale*
B *River Bed*

ıe Rosenkrantz Tract, Section 18, Township 3 south, Range 13 west, S. B. [., gas has been struck in sinking for artesian wells, but in what quantity failed to ascertain. To the south and west, on some of the low-lying .lls, exudations of asphaltum can be seen emerging under the gravel. ll the clays which surround and in part underlie the town furnish an :cellent material for brickmaking, for which purpose it is largely used, veral large brickyards being in active operation.

GRAPHITE

Northeast from Los Angeles, about twelve miles distant in the San afael Range of mountains, close to the road in Verdugo Cañon, in Section Township 1 north, Range 13 west, we find a deposit of graphite between ılls of micaceous clay schist, coursing north 25 degrees west, and dipping) degrees to the west, at an altitude of one thousand eight hundred feet. his vein, where it has been uncovered, shows a width of about twenty et. The parties who control this property state that they have had it sted, and that it contains between 60 and 70 per cent of carbonaceous atter, with some iron. It is favorably situated for working, being but a ıort distance from the Glendale and Los Angeles Railroad, to which a ling could be made. A drift of about forty feet in length at the level of e road would crosscut the vein at a depth of fifty or sixty feet, and this what the owners purpose doing.

Not far from this deposit, in a low range of hills three miles from the ain range, at an altitude of eight hundred feet, is an extensive calcite posit, coursing north 45 degrees east, and dipping 87 degrees east; also, the near neighborhood, some sulphur springs.

SANTA MONICA.

Going from Los Angeles by way of the railroad to Santa Monica, we irt to the south of the Santa Monica Range, which has a northwest and utheast trend. This range terminates in abrupt bluffs facing the ocean, an altitude of from seventy-five to one hundred feet, and shows unaltered ays and sandstones overlaid in places with partly cemented gravel, espe-ally ~~around the~~ neighborhood of Arch Rock, ~~which is formed~~ entirely of mented gravel, partly worn away by the action of the waves.

About four miles up the coast and about one hundred rods up one of the small cañons that discharge on the beach, there are some bituminous shales exposed coursing northwest and southeast, and dipping at an angle of about 10 degrees to the east. Here some parties started a tunnel for coal; they have gone in on the pitch of the strata about two hundred feet, but would not give any information as to the result of their labor. Beyond Arch Rock the coast line swings out to the west until it reaches Point Dumas, where there is a large deposit of diatomaceous earth. Large pieces of this rock become detached and fall into the ocean, and are washed across the bay to the neighborhood of San Pedro. Turning to the southeast from Santa Monica and following the beach line, we find the same kind of bluffs coming down to the edge of the water, dipping slightly (about 10 degrees) inland, forming a tableland, over which the road passes. This mesa is indented and cut up by small cañons draining down into the ocean.

Two or three miles before reaching Redondo Beach we find some bluffs of very fine, pure clays of a yellow, brown, and ocher tint, very suitable for mineral paints, for which they have been successfully tested by practical painters. Opposite the coast here is the Island of San Catalina, which belongs under the jurisdiction of Los Angeles County, and of which we will speak later.

SAN GABRIEL.

From Los Angeles to the east, going along the flank of the San Gabriel Range, we come to the cañon and creek of the San Gabriel. The cañon is very tortuous in its course, the banks extremely rugged, showing the effects of heavy denudation on its naked metamorphic rockbound sides. The whole country gives evidence of violent disruptions. Three or four miles up this cañon we find the works of the Victoria Gold and Silver Mining and Milling Company, an English company holding several claims, two of which are patented, in Sections 12 and 13, Township 1 north, Range 10 west.

They have a beautiful little ten-stamp mill arranged for the Boss continuous process, run by two breast wheels. The company has made a large number of excavations, but as the mill had never ran, and we could not find any ore dump, and all parties connected with the works were extremely reticent, we presume the vein or veins must be small, if present at all. The company themselves claim to be still prospecting.

In the same section, but further up the mountain, are the Kelsey and Mint claims, which have been the cause of so much excitement in Los Angeles in the last two or three months, on account of the amount of native silver said to have been found there, and on account of the combination of silver and cobalt ores, similar to ores found formerly in Schneeberg, in Saxony. Nobody was at work there at the time of our visit, and the works were locked up. The following statements are taken from a report that was made on the property by a Mr. Roberts: He states that a fault south of the vein displaces about eight hundred feet of the vein. On the south side of the fault is micaceous sandstone. He gives the dip as 25 degrees to 30 degrees east, the strike north and south, and the width of the vein from four to six feet. On the north side of the fault considerable hornblende is in the rock, inclining it to gneiss, but more massive than schistose. He states it to be a true fissure vein, and gives the following list of minerals as occurring: Native silver, silver glance, chloride of silver accompanied by carbonate of copper, iron oxide, black oxide of manganese; to which he might have added erithrite, cobalt glance, and earthy cobalt.

The gangue, according to the report, consists of baryta, chalcite, and quartz.

Further up the cañon, in Sections 21 and 22, Township 2 north, Range 9 west, S. B. M., parties are working the auriferous gravels that flank the mountain side. They have more resemblance to the pliocene gravels of the northern counties than the auriferous gravels observed in Soledad Cañon, and in Palomas Cañon and its tributaries.

The gold from these gravel deposits is rough, and worth from $16 to $17 per ounce. A good deal of prospecting has been done on the mountain ranges bordering on the San Gabriel Cañon, and we were shown specimens of silver, lead, and silver copper ores, said to have been found on the west branch of these mountains, which, if present in any appreciable quantity, would give a great impetus to the mining business in this section. Following along the flanks of the Sierra Madre, on the southeast side of one of the spurs running down towards Pomona Valley, near Lordsburg, about four miles from the railroad, in Section 26, Township 1 north, Range 9 west, S. B. M., parties have opened a quarry of building stone, at an elevation of one thousand three hundred and fifty feet. The rock is a red, fine-grained eruptive rock, coursing north and south, and dipping to the east at an angle of 75 degrees; it is bordered by a red gneiss rock, which is also to be quarried for building purposes. The parties claim a very high crushing coefficient for it; also that it is absolutely indestructible by fire, having been repeatedly heated to a white heat and thrown into water without checking in the least.

PUENTE.

As this section of the county has been visited and described by Prof. W. A. Goodyear, E.M., in the State Mining Bureau Report for 1887, I will merely add that at present they have fourteen wells, situated in Sections 34 and 35, Township 2 south, Range 10 west, S. B. M. Their average depth is one thousand feet. All the oil is brought to Los Angeles, where it is mostly used for fuel purposes. There seems to be more shale than sandstone here, as compared with the Pico Wells.

SANTA ANA.

In the Santa Ana Valley, six miles from the town of the same name, in a westerly direction, at a place called Fairview, a number of artesian wells have been sunk with favorable results. They were sunk through strata of gravel, clay, and sand to a depth of over one hundred feet in some cases. In one of these, at a depth of eighty-seven feet, the drill passed through a large redwood log, a species of timber that is not found anywhere in the neighborhood at the present day. In another well that was sunk to a depth of over one hundred feet, the drill brought up twigs of oak, and also acorns.

To the east of Santa Ana, in the neighborhood of Santiago Cañon, on the spur coming down from the main range, lead, silver, and quicksilver ores have been found. The ores were shown us, but as the locations had not been secured, the exact locality was withheld.

EL TORO.

At El Toro Station, on the Santa Fe road, about three miles south of the railroad, is a deposit of limestone cropping out over the surface, at least over an area of twelve or fifteen acres. It is cut through by Aliso Creek,

on the banks of which there is a highly tenacious clay that, used in conjunction with the limestone, will form a cement equal to the best Portland. Specimens of this clay were sent to the noted porcelain factory in Meissen, in Saxony. It made a fine quality of chinaware, but all of a pink color. The depth of this limestone or, indeed, its extent in any direction, could not be accurately stated, as the formation lies very flat, and no explorations have been made to prove it. It is fossiliferous, and is overlaid with arenaceous shale impregnated with salt. Not far from this, and possibly forming a part of it, we find, at the Modjeska switch, another bed of shell lime, which, with clay, makes good artificial cement. Here we have a distinct bed of clamshells striking northeast and southwest, dipping 10 degrees south, five feet thick. It is overlaid by fossiliferous sandstone and underlaid with limestone. Several years ago parties undertook to burn lime here, but owing to wrong dimensions of the furnace, and possibly admixture of adverse substances with the raw material, the enterprise failed. (See State Mining Bureau Report, 1889, p. 865.)

SAN JUAN CAPISTRANO.

From El Toro to San Juan Capistrano is a distance of nineteen miles by railroad. The town is partly surrounded by low hills of soft fossiliferous sandstones, which extend down to the ocean, about two and one half miles distant. The altitude is three hundred and fifty feet. The range courses north and south, and dips slightly to the west. Two creeks run through the old Mission town, and unite before entering the ocean. The road northwest along the beach takes up over the mesa, which butts onto the ocean in bluffs of about one hundred feet in height, composed of unaltered sandstones and shales, and in some few places beds of cemented gravel. Along this beach in the debris, among other minerals, we found a specimen of chrome mica (fuchsite). Half way between San Juan by the Sea and Arch Beach is a dry creek that in the rainy season flows quite a body of water, and is called Salt Creek. Near where it has its head on the mesa the Mexican sheepherders procure rock salt and give it to their American neighbors when asked for it, but they will not divulge where it is obtained. Near where Aliso Creek empties into the ocean, and back inland a short distance, bituminous shales crop out, coursing apparently north 30 degrees west, and dipping at an angle of about 15 degrees. Arch Beach, a seaside resort, is situated seven miles north of San Juan. Back from there, about two miles on the range, a large amount of fossilized wood is picked up laying over the surface of the ground. At Arch Beach the bluffs are composed of layers of conglomerate rock and unaltered sandstones, with very thin streaks of limestone banded through it. The dip here is about 40 degrees to the west.

LASSEN COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

As inadvertently some mistakes were incorporated in last year's report, in reference to the principal mining camps of Lassen County, the following partial repetition and correction has been made.

Lassen County, bordering on one of the best mining counties of California, being separated from Plumas County by a spur of the Sierra Nevada, has, so far, developed but little mineral wealth, a few claims having been prospected on Diamond Mountain, near Susanville, the county seat, that have yielded some gold. Veins of silver and gold ores have also been found on the southwest side of Eagle Lake, but mining as a regular business has only been prosecuted in the extreme north of the county, sixty miles north of Susanville, and nine miles from the Modoc County line, in what is known as Hayden Hill Mining District. This hill, named after one of the first locators, who is buried there, is one of the highest points of a spur running out on the eastern slope of the Sierra Nevada; its altitude is given as seven thousand five hundred feet. The mines were discovered nearly twenty years ago, since which time they have been more or less continuously worked, yielding to the world's gold supply a little over $1,000,000.

At the present date there are nine mines being worked on the southwest side of the hill, the most of which are extracting pay ore in more or less quantities.

The whole of the country is covered with a volcanic flow, making it extremely difficult to exploit for minerals. On the north side of the hill, exposures show a large bed of decomposed felsite; on the southeast side, are basalt and trachyte. Besides these we find conglomerates, breccia, altered sandstones, and arenaceous slates, with specimens of coarse-grained jasper, obsidian, volcanic tufa, etc. The action of heat and water are both plainly to be traced; in fact, it appears as if, after having been in active eruption in the near neighborhood of what now forms the hill, the fires have died out, leaving hot mineral springs to continue their solfataric action, until these likewise have disappeared, leaving the hill almost destitute of water.

There are two distinct systems of mineral veins—one a series of large quartz veins, with a general north and south trend, and dipping nearly perpendicular, very much eroded near the surface, containing but little gold in the croppings (never more than $5 or $6 per ton); and parallel to these, at no great distance, a younger system of fissures, having about the same course, but with an entirely different filling, being mostly country rock more or less decomposed, metamorphosed, and showing a large percentage of black oxide of manganese, with bowlders of quartz and quartz gravel, and in part, instead of a clay gouge on the wall, a layer of gold-bearing quartz, averaging two or three inches, firmly attached to the foot wall. It is on these systems of veins that the mining operations are pursued. The pay is in shoots mostly on the foot wall side. The walls are either felsitic or a conglomerate, pitching toward the older system of veins,

and the ore seems to be richest where the felsite forms the wall. At a depth of about one hundred feet all through these veins there appears to be a barren streak. Little side feeders, running east and west across the main system, contribute to enrich the main veins for short distances, running the ore up from the usual average of $15 to $20 a ton to sometimes into the thousands. The gold is heavily alloyed with silver, being worth from $12 to $13 per ounce. Occasionally electrum is found with the gold. Also, from microscopical examination of the gold made at the State Mining Bureau, it was found that there are two qualities of gold in the veins—a gold that has been fused (this is found in the east and west feeders) and a gold that has been precipitated out of a solution (which is the quality of gold in the main vein).

None of the mines are worked to any extent below the three hundred-foot level. There is a great opportunity here to open all these mines through a deep tunnel that would cut the veins at a depth of seven hundred or eight hundred feet, but, for lack of unity and the necessary capital, it has never been started. The principal claims are:

The Providence, or Mount Hope. This was the first paying mine on the hill, and has yielded in the neighborhood of $125,000. At a depth of about one hundred feet they ran into a chalky clay-rock that cut off the pay, and for want of capital on the part of the owners to penetrate through this clay, the mine is not being worked at present.

The Golden Eagle adjoins the Providence on the east. This is one of the best developed mines on the hill. It is opened by tunnels and shaft to a depth of about three hundred feet. It is now being worked under a lease. This mine has a mill and water right about two miles from the mine.

North of this claim are the Brush Hill Claims, Nos. 1 and 2, formerly one full claim. It is now segregated. The one claim holds three fifths of the ground and the other two fifths. For a long time this mine kept a ten-stamp mill running on rock that averaged over $80 a ton. The average of the ore at present is $25 per ton. This mine has some water in the bottom, but not enough to require pumping engines. Brush Hill No. 1 is being worked by the owners; No. 2 has been under a lease. Both of these companies own small stamp mills, run by water power, about two and one half miles from the mines.

East, and adjoining the Golden Eagle, is the Excelsior Mine, worked by its owners through a shaft sunk on the vein, and they are meeting with good success. Their vein is presumably an extension of the Golden Eagle vein, but thrown out of the course by a large fault.

North of the Providence and northwest of the Golden Eagle and Brush Hill, is the Evening Star Company. They are working on an extension of the Golden Eagle and a cross of that vein with the Providence. This company has a shaft and a drift one thousand feet long to work through, that are connected at a depth of two hundred and forty feet. Besides this, they have a shaft down on the vein at the east end to a depth of one hundred and fifty feet. For nearly three hundred feet the tunnel went through a species of kaolin, that seems to dip under the hill on the north and west, and which is capped on top by a conglomerate rock. This mine has been the most continuous ore producer, although it does not show the largest output of gold.

The Juniper Mine has been in many respects the most remarkable of all the Hayden Hill mines, as in the course of three or four years, with four arrastras, it has produced half a million dollars; then at a depth of less than three hundred feet they met the clay, and since then no exploi-

tations have taken place. Leasers have gone over the old works, finding it profitable to scrape down old walls and timbers, and work over old waste dumps, and it is in the hands of those men to-day, awaiting some man with energy and capital to further develop the property.

Adjoining this claim is the Blue Bell, which paid largely near the surface, but it is not being worked continuously at present.

This mineral belt can be traced by croppings north from Hayden Hill into Modoc County, but nowhere on it has any profitable work been executed.

SAN BERNARDINO COUNTY.

By James H. Crossman, Assistant in the Field.

Volcanic cones occur in this county, and the short mountain chains and isolated peaks, with which the desert region is dotted, are fissured with metalliferous veins. Among them, gold-bearing veins charged with the several ores of silver occur. Copper abounds in metallic form, and as carbonate, oxide, and sulphide. Ores of lead are found in veins of great strength. Immense bodies of iron ore are also met with, chiefly hematite and magnetic; the latter veins vary from twenty to one hundred feet in width. Pure rock salt is also found in large quantities, a more particular reference to which is made under a special head elsewhere in this report. Marble is found near Oro Grande, and in Colton, and in Old Woman's Mountain. Asbestus and mineral earths suitable for pigments are known to exist, although not yet available for commercial purposes. Aside from the supply by artificial reservoirs and natural sources, water can be obtained in many places in the desert, both north and south of the San Bernardino Range, by sinking wells. It is often reached within a few feet below the surface. One hundred and twenty-one completed artesian wells are said to furnish thirteen million gallons of water every twenty-four hours.

North of the San Bernardino Range of mountains the desert country contains the following mining and railroad towns: Victor, one hundred inhabitants; Oro Grande, one hundred and fifty inhabitants; Calico, four hundred inhabitants; Ivanpah, twenty-five inhabitants; Providence, fifty inhabitants; Barstow, one hundred and fifty inhabitants; Needles, four hundred inhabitants.

Providence, Kingston, and Clark's Mountain Ranges show, at an altitude of about four thousand feet, a considerable growth of timber that can be utilized; but below that level, the cactus, juniper, and sage, together with an occasional grove of mesquite, form the only fuel available. Fortunately the Gallup Mines in New Mexico furnish an excellent quality of coal. This is transported over the Atlantic and Pacific Railroad, and delivered at several points on the line of the road. In the near future, when the Utah Southern Railroad shall have extended its lines through these regions, excellent coal from Milford, in the Great Salt Lake Basin, can be laid down in San Bernardino County at a cost not to exceed $6 per ton.

STATISTICAL.

Within the confines of this county there are in operation sixteen quartz mills, dropping one hundred and eighty-seven stamps, the cost of which would be about $600,000. The silver bullion annually shipped from Daggett, owing to the low price of the metal, has not been so great for the past two years as before that time.*

*Note.—The value of the shipments of silver bullion from Daggett is difficult to determine, our assistant in the field having no guide in the matter, excepting by shipments through Wells, Fargo & Co. Estimate has been made from the opinions of business men *in the county* conversant with the facts.

number of men employed in mining in this county is estimated at hundred.

THE TOWNS.

tor is a station on the California Southern Railroad, and has an alti-
of two thousand seven hundred and thirteen feet above sea level. It enterpot and depot for the mining districts situated in Holcomb and Valleys, for the Old Woman's Springs, and the Morongo Gold and Mines. It lies twenty miles southwesterly from Ord Mountain Dis- Close to the town are large quarries of excellent granite, which are ntly worked. The stone finds a ready market in the southern part State.

Grande is situated on the banks of the Mojave River, about forty-iles northerly from the City of San Bernardino. Lime is at present incipal product. It is shipped in large quantities to various parts of ate, and also to Lower California. Two large, double, patent kilns pt constantly burning to supply the demand, and the business gives yment to a number of quarrymen, kilnmen, woodchoppers, and ters.

adjacent hills and low ranges of mountains, within a radius of from twelve miles, have long been known to contain veins of gold, silver, nd other minerals, which, owing to their rebellious character, cannot ked by the ten-stamp mill erected for the purpose.

iculty in reducing these refractory ores will soon be overcome, how-s a fifty-ton smelter is being built for their special treatment.

motive power will be water supplied by a ditch from the Mojave carrying one thousand five hundred miner's inches, with a thirty-essure head at the outlet.

stow lies at the junction of the Atlantic and Pacific and the Califor-uthern Railroads, and has an altitude of two thousand one hundred ve feet above sea level. Water for power is easily obtainable from ojave River, upon the south bank of which the town is situated.

gett is on the line of the Atlantic and Pacific Railroad, at an alti-f two thousand and two feet above the sea. It is situated near the of the Mojave River, about eighty-five miles in a northerly direc-om the City of San Bernardino. This town is the receiving and dis-ng point for the extensive silver mines of the District of Calico, Ord ain, Lava Beds, Alvord, Solo, Silver Lake, Resting Springs, and the of the southern part of the Death Valley country. A great quantity of borax is shipped from Daggett, the product of mines in Calico Range, t some twelve miles northerly from the railroad.

co was laid out as a town in 1882, and at that time active mining ions were commenced.

first mill for the reduction of ores in this district was built at Haw-tation, and after running about five years, caught fire and was con-. During this period the town increased in size and population till, n 1882 and 1884, it became a place of eight hundred inhabitants. latter year it was almost wiped out by fire, but was rapidly rebuilt, me with good, substantial edifices. But, unfortunately, in one year he date of the first burning, a second conflagration laid the town in From the happening of the last calamity until the present time has just about held its own.

uld the present Congress declare itself on the silver question in a enhance the price of that metal, there are many low-grade mines

lying almost within the town limits of Calico that can be worked with profit.

MOUNTAIN RANGES.

In places on the northern slope of the San Bernardino Range of mountains, unaltered sandstones occur in immense quantities, particularly in the vicinity of Holcomb Valley. The elevation of the summit at Cajon Pass is three thousand eight hundred and nineteen feet above sea level.

Ord Mountain.

Eagle Peak is the name of the summit of this important eminence, and stands a marked feature in the landscape. Its central axis is granitic, with a northwesterly and southeasterly strike. Feldspathic, porphyritic, and many kinds of igneous rocks occur; both talcose and magnesian rocks are also seen.

The Lava Bed Mountain.

This mountain is a prolongation, in an easterly direction, of the Ord. Its course and stratification are north 22 degrees east. Clark's Peak dominates all others in the range, rising to an elevation of four thousand five hundred feet, and lies twenty-six miles easterly from Daggett in an air line.

The axis of this range is granite, so much metamorphosed by subterranean heat and thermal waters that its character is scarcely recognizable. Being in the immediate vicinity of two very distinct volcanic vents, within four or five miles easterly, it has felt their effects. This mountain is traversed by fissures, the strike of which is north 70 degrees west. They are filled with quartz and brecciated volcanic products of many varieties of rock.

Victor Mountain.

In this granitic range lie valuable quarries that are being worked and rapidly developed. The range is two miles long by one wide, with a northerly and southerly strike. Lying to the north is an extensive lime belt one mile in width, the strike of which is easterly and westerly, with a longitudinal extent of about twelve miles, where veins carrying gold, silver, copper, and lead occur.

Oro Grande Mountain.

This mountain is an isolated peak ten miles long by five wide at its widest part. Its direction is northerly and southerly, stratification northeast and southwest, formation largely volcanic, and composed of porphyritic rocks, volcanic debris, and a brecciated mass of material, through which run strong dikes and veins of metalliferous rocks.

The Avawatz Range.

About sixty miles in an air line, nearly due north of Calico, lie the Avawatz Range of mountains, which rise to an elevation at the highest summit of a little more than five thousand feet.

The axis of this range is similar to that of the Ord Mountain, which it resembles in a marked degree, both as to the character of its various rocks and their mineral contents. The course of this range is northwesterly and southeasterly; length about twenty-five miles; width about twenty. On its slope, and bordering on the western side of Death Valley, are found many valuable saline deposits.

Kaolin and foliated talc of the finest quality are also found in great abundance. Near the summit of the highest peaks some rich veins and deposits of gold, silver, copper, and lead have been discovered, and, ten years ago, were extensively worked.

About thirty miles easterly from Cave Springs, located some two miles and a half easterly from the summit of this mountain range, and on the road between Daggett, the Amargosa Borax Works, and Resting Springs Mines, a high range of mountains, gloomy and desolate-looking, loom up. This is the first range encountered after crossing the southern rim of the Death Valley basin, and is distinguished by almost perpendicular peaks; the highest, Kingston Peak, is a prominent landmark. The range and the peak, with the spring at its base, are named after Kingston, a former mail carrier between Salt Lake City and San Bernardino. On the northerly end of this range large deposits of argentiferous galena are found. These were extensively worked at Tecopa, once a flourishing mining town.

The general character of the rock is limestone (dolomitic). About six miles northerly from the above named place, in a low range, apparently an offshoot from the main one—the Kingston Mountain and District—occur the extensive argentiferous lead deposits that surround Resting Springs. Northward from the springs the range is badly broken, until finally lost in Ash Meadows, twenty-five miles distant.

Traveling about forty miles in a southeasterly course from Tecopa Clark's Mountain is reached, a place famous for the richness of its silver deposits. Its axis is a hard, blue limestone. The mining town of Ivanpah is situated at the southern base of this short range of mountains; on the southwesterly slope the Mescal mines and mill are located. Providence, a mining town in Trojan District, in the Providence Range of mountains, lies forty-two miles almost due south from Ivanpah. It is on the southeasterly slope of the range, in a region noted for the amount of rich silver and gold ores extracted from the many veins and deposits found within its confines. Southeasterly, at a distance of forty miles, the peculiarly marked range known as

The Old Woman's Mountains

is reached, its extreme northerly point being eight miles distant in an easterly direction from Danby, a watering station on the Atlantic and Pacific Railroad. In the northwesterly portion or end of the range, and in the granitic and slate formations, small ledges, very rich in gold and silver, have been discovered within the last two years. During the same time a large and extensive ledge of carbonate of lead and galena was found, and developed considerably. This important ledge is traceable about eight miles. It runs through the mountain from its extreme northeasterly end to the extreme southwesterly extension, varying in width from ten to fifty feet. At the extreme southerly end, in a dolomitic limestone formation, some rich veins of silver-copper glance and horn silver have also been found; but, owing to the scarcity of water, little prospecting has been done upon them as yet.

Thirty-five miles from the above mentioned range is a well known landmark called

Old Dad's Mountain,

which forms the southerly extension of the Providence Range of mountains. Standing out in desolate boldness, its lofty summit is covered with a scanty growth of scrubby nut-pine and juniper. The formation is granitic and porphyritic. Small ledges rich in gold have been found near its southeastern base, where a limited amount of development has been made.

In the mountains bordering on the west side of the Colorado River there has been but little prospecting and but scanty mining development.

RIVERS.

The Mojave,

The most important river in the desert of the same name, is formed by three forks, which take their rise at Halcomb Valley, in the San Bernardino Range of mountains.

From its source the course is northerly for a distance of seventy-five miles in an air line; it then takes an easterly direction for sixty miles, and finally sinks in Soda Lake. Within its entire length, about two hundred miles, the river in the dry season rises to the surface, and afterwards sinks eight times. Its first disappearance is at the forks, twelve miles above Victor, and its flow is subterranean for a distance of twelve miles. It rises at Victor and sinks again in the sand for five miles; appears again near Oro Grande, runs on the surface for five miles, and sinks between that place and Cottonwood Station, on the line of the California Southern Railroad; rises at Cottonwood, is visible for one mile, then sinks for a distance of fifteen; rises at Barstow, and is seen at this point for half a mile, then disappears for six miles, coming to the surface at Fish Ponds, runs a mile in view, and goes out of sight again for twelve miles. Coming to the surface again at Hawley's Station, this hide-and-seek river runs for about half a mile, then sinks and is not afterwards seen until Camp Cady is reached; here it is visible for a mile, where it sinks again for eighteen miles to rise once more at Cave Cañon. From this point the flow is visible for ten miles, till the river sinks for the last time near Soda Lake, excepting in the season of floods; then it rises twenty miles below the lake, and after uniting with the Amargosa disembogues into Death Valley near Saratoga Springs. During the spring months the river attains considerable volume, owing to the supply from melting snows, and is impassable where not bridged, excepting a few fords or crossings. From seven to nine months in the year the Mojave seldom carries less than ten thousand inches of water, miner's measurement.

Furnace Creek

Rises on the westerly slope of the southerly end of Grapevine Mountain, in the Death Valley or Funeral Range. It receives its supply, about two hundred inches, miner's measurement, from a spring pure and cold, and runs in a westerly direction for about three miles; then sinks in the sands of Death Valley. From this creek the extensive borax refining works of William T. Coleman & Co. obtain a supply of fresh water for domestic and other purposes.

The Amargosa

Has its source in the State of Nevada, about thirty miles southeasterly from the State Line Gold Mines in Gold Mountain, and makes its first appearance at the northerly end of the oasis in Nye County of that State. Its general course is southerly until after passing through the Amargosa borax fields, near Resting Springs, down through a deep cañon, close to the Salt Springs Gold Mines. There it suddenly changes to a direction almost due north, and is finally lost sight of near Saratoga Springs, Death Valley. The length of the Amargosa is about one hundred and forty miles.

It repeatedly comes to the surface, flows a short distance, and then sinks, its waters being absorbed by the sandy material, until a higher plane of bedrock is reached, when they emerge again to view.

During its flow the river takes up to its full capacity the alkaline salts in the soil through which it courses. When it comes to the surface the water is surcharged with them, and forms a dense briny solution, so perilous that, though to the eye it appears pure and wholesome, death follows to the man or beast that may chance to drink of the stream. When the action of the sun evaporates these fatal waters, the residue is soda, borax, and other alkaline substances.

The Silver Valley Land and Water Company.

At Daggett the "Submerged Dam and Water Company" has been incorporated, and works are being constructed to utilize the subterranean waters of the Mojave River as a motor, and for irrigation.

A submerged dam one thousand six hundred feet in length by twelve feet n height is being constructed at Fish Ponds, about three miles above Daggett on the river. The purpose of this dam is to convey the hidden waters f the river from this point by canal, flume, and pipe to and below the own. This will require three miles of canal, one thousand five hundred eet of tunnel, two thousand six hundred feet of pipe, and two thousand eet of fluming. The canal will be twenty feet wide at the top, fifteen feet ride at the bottom, and five feet in depth. Water will be taken out four eet below the surface, at an elevation of two thousand and fifteen feet bove the sea, and discharged at a height of one thousand nine hundred nd seventy-five feet, thus furnishing power for machinery and mills, and lso sufficient water to irrigate a large tract of valuable agricultural land ying below the point of discharge.

The capacity of the canal will be fifteen thousand miner's inches; the rade, fourteen feet to the mile. The submerged dam will be a substantial tructure of concrete cement and stone, of sufficient thickness at its base, esting on a bedrock of granite. Three reservoirs will be built on the line f the canal, each to contain five million gallons of water. These reseroirs will afford place for surplus water in the flood season.

Below the discharge point lie two hundred and eighteen thousand acres, urveyed and suited for agricultural purposes, a portion of which is owned y the company proposing to construct this canal.

Wheat and other cereals can be grown, also alfalfa and vegetables, ogether with citrus and semi-tropical fruits.

Outside of the company's possessions there is an area of one hundred housand acres of the same kind of land, susceptible of irrigation. The vaters of the projected canal can be taken to Soda Lake through Cave Cañon, and eastward as far as the valley lying south of Lavic Station, on he Atlantic and Pacific Railroad.

The Irrigating Ditch

Running from Lytle Creek, in the eastern part of the San Gabriel Mountains, is twelve miles long, and carries fifteen hundred miner's inches of water. Its dimensions are: four feet wide on the bottom, six feet at the op, and two and one half feet deep. It is cement lined, the grade two hundred feet to the mile, and the cost per mile $8,000.

This ditch irrigates six hundred acres in the northwest part of San Bernardino County. The irrigation season commences in April and ends in

October. Extensive reservoir sites can be secured on the line of this ditch. Catchment basins are numerous and not expensive to construct.

A large amount of water, much needed for irrigation purposes in this region, is allowed to run to waste.

The Oro Grande Canal.

At Oro Grande, a canal from the Mojave River carries one thousand seven hundred inches under a four-inch pressure, and has a thirty-two-foot pressure-head at delivery. This has been utilized for power to drive a ten-stamp mill, which is lying idle at present; the power will be used to run the fifty-ton smelter now being erected at this place.

VOLCANIC PHENOMENA.

At a place on the line of the California Southern Railroad, below the Point of Rocks Station, the first strong evidence of volcanic action may be observed. The rocks are metamorphosed and discolored; red, blue, yellow, purple, and green stains meet the eye. Signs of volcanic activity are seen from this point in northerly, northeasterly, and easterly directions for a distance of eighty-five miles. Volcanic cones occur, with craters on their summits, in many places. Streams of once molten lava, as fresh in appearance as if they had just ceased flowing, cover large areas.

The first volcanic cone of note is in the Ord Range, ten miles south 10 degrees east from Daggett; its lava flow was northerly, and discharged into what is now a dry lake, a basin-shaped depression lying east of Warm Springs. The next occurs in an easterly direction from Daggett, and distant from that place twenty-four miles. The flow from this crater was westerly six miles, and emptied into the same lake or basin.

The next extinct crater is of greater dimensions than the last mentioned, and is situated three miles easterly. The lava flow from this crater was easterly, discharging into another dry lake in Section 31, Township 9 north, Range 3 east. This cone has an elevation of about four hundred and fifty feet, with a base diameter of three thousand feet; the width of the crater at the summit is seven hundred and fifty feet, by one hundred and fifty feet deep. At that depth its pipe or shaft has an outlet, through which the lava was discharged. Dry Lake No. 2 has an area of about twenty-four square miles, on which two wells have been sunk, respectively sixty and ninety feet in depth, through earthy and volcanic debris. On reaching the lava an inexhaustible supply of nearly fresh water is obtained.

Southeasterly from this, at a point two miles and a half northerly from Ludlow Station, on the Atlantic and Pacific Railroad, four volcanic vents are found. Eighty miles distant, on the line of the same railroad, lying southwesterly from Siberia Station, another extinct volcanic cone may be seen, much larger than either of the others described. Easterly two others occur between Bagdad and Amboy Stations. There are eleven altogether, the two last mentioned being the easterly extremity of this special volcanic disturbance. From this point to the Colorado River, a distance of eighty miles, no evidence of volcanic action is met with.

Forty-five miles northerly from Bagdad Station, in Township 13 north, Range 12 east, San Bernardino Meridian, a volcanic center occurs where six extinct craters are seen, the lava flow from which covered the entire township site with scoric and molten masses.

The flow from these vents took a westerly course, and discharged into *Soda Lake*, the surface of which is now covered with an efflorescence of

salt and soda over an area of seventy square miles. This lake is situated in Township 12 north, Range 8 east, and Township 13 north, Range 8 east, San Bernardino Meridian.

In the area first described, long lines of rents and fissures are seen, as well as craters with an immense quantity of breccia. The lava-bed range is a striking example of the many *volcanes de aqua* (water volcanoes) once existing in the area described.

One mile northwesterly from Daggett is Table Mountain, a marked feature in the landscape. It rises from its base to a height of two hundred and fifty feet, and one mile and one half long, by three quarters of a mile wide. Its sides have a gentle slope, and there is a bench of tableland on its top. This mountain is formed entirely of volcanic debris cemented into a solid mass of stone, which, after being cut and dressed, is used for building purposes in the neighboring town.

WARM SPRINGS.

The first evidence of thermal water in the Mojave Desert is seen at a point ten miles east of Daggett; elevation one thousand six hundred and seventy feet. These springs lie on the westerly edge of a dry lake, the dimensions of which are six by twelve miles. The surface is covered with alkaline and saline efflorescence. The lake has received the main flow of two now extinct craters. These springs furnish a steady flow of about ten inches of water, miner's measurement, varying in temperature from 50 to 85 degrees. In quality it is pure and without marked flavor.

In the Mojave Desert, northerly from this point, are a great variety of mineral springs of all temperatures from ice-cold to the boiling point.

Saratoga Spring is situated in Township 18 west, Range 5 east. The temperature of the water varies from 78 to 90 degrees.

The spring proper is a pool seventy feet in diameter, which overflows and forms a small lake. A person bathing in Saratoga Spring can sink no deeper than the chin; he stands on what is apparently quicksand, and the upward force of the rising water sustains him. This pool is filled with myriads of fish from two to four inches in length, resembling the species known as silver trout. As they strike the naked body of a bather, they cause a very unpleasant sensation. When cooked as pan fish they are good food, fat and palatable. Though the Chinese and Indians catch great quantities of them, the supply is not perceptibly diminished. The method of taking the fish is singular enough. A handful of cornmeal is put in a kettle or pan, which, on being sunk a little below the surface of the water, is soon filled with the finny prey. The utensil is then withdrawn, and the fish are ready to be fried without further trouble. The water is pure and wholesome, and its overflow forms a laguna, on the surface of which ducks and other waterfowl disport, feeding on the fish that come from these subterranean depths.

MINING DISTRICTS.

San Bernardino County contains within its borders the following mining districts, some of which, since their formation, have been subdivided. The names and boundaries of the subdivisions are given as accurately as possible under the circumstances.

Gold and Silver Mining District

Is bounded on the south and west by Deer Creek, on the north by the desert, on the east by Holcomb Valley.

Morongo Mining District

Is bounded on the northwest by the Black Hawk District, easterly by the desert, and south by the head of the White Water.

Brier Mining District

Commences at the northwest corner of Borax Lake District; thence westerly to the foothills to a point; thence southerly, following the foothills to a point; thence to the southwest corner of Borax Lake District; thence to the place of beginning.

Holcomb Valley District.

Boundaries unknown, but it comprises the area in Ranges 1 and 2 east, and Township 2 north.

Borax Lake District.

Boundaries unknown, but comprised in the area adjoining Brier District; twelve miles square, or four townships.

Ruby Mountain District.

The northwest corner is Horseshoe Mountain; thence westerly to the north of Rattlesnake Cañon; thence southerly to Antelope Springs; thence easterly to Gus Knight's mill; thence northerly to the place of beginning, comprising Township 2 north, Range 4 east.

Twenty-nine Palms District.

Comprising Township 1 north, Range 8 east; Township 1 north, Range 9 east; Township 1 north, Range 10 east; Township 1 north, Range 11 east; Township 2 north, Range 9 east; Township 2 north, Range 10 east; Township 2 north, Range 11 east; Township 3 north, Range 8 east; Township 3 north, Range 9 east.

Ibex (formerly "Sacramento Springs") District

Is bounded on the north by the old Arizona wagon road, on the east by the Colorado River, south by the Needles, and west by the Trojan Mining District, and commences at the northwest corner of Township 9 north, Range 20 east.

Burrows District.

Commences at the southwest corner of the mouth of Burrows Cañon, where the Mojave River enters into the desert; thence up the line of the river to the westerly line of the Holcomb Valley Mining District; thence northerly to the desert; thence along and skirting the base of the mountain and following the edge of the desert to the place of beginning.

Morongo District.

Beginning at the southerly corner of Warren's Well, running in a northwesterly line to the mouth of Rattlesnake Cañon, west to Granite Mountain; thence southeast to a point in Big Meadows due west of Warren's Well; thence easterly to place of beginning.

Solo District.

Commencing at a point on the northerly end of Cronise Lake; thence southerly to Mesquite Springs; thence easterly to Marl Springs; thence

y to Halloran Springs; thence westerly to northeast corner of Five istrict; thence northwesterly to point of beginning.

New York District.

ıencing at the southwest corner of Township 12 north, Range 15 ence north twenty-four miles; thence east eighteen miles; thence 'enty-four miles; thence west eighteen miles to place of beginning.

Exchequer District.

ıencing at the southeast corner of Township 10 north, Range 19 ence north eighteen miles; thence west twelve miles; thence south ı miles; thence east twelve miles to place of beginning.

Grapevine District

led on the west by a dry lake, on the east by Calico District, south Iojave River, and north by the Mojave and Death Valley wagon ommencing at the southwest corner of Township 10 north, Range 1 d running along the west boundary of Calico District to Paradise ten miles distant; west two townships; thence south ten miles; wo townships east to place of beginning.

Temescal District

ıes Township 3 south, Range 5 west, and Township 3 south, Range

Ord Mining District.

ning at the southwest corner of Township 9, Range 3 east; thence ght miles; thence to northeast corner of Section 15, Township 10 Range 4 west; thence south sixteen miles; thence west four miles; south twelve miles; thence west twenty-six miles; thence north- to place of beginning at summit of the mountain.

Black Hawk District.

nencing at Rabbit Springs; thence sixteen miles easterly to Old 's Springs; thence southerly to the east side of Cottonwood Cañon ıe divide of the mountain to a high point easterly from the Nichols in Morongo District; thence westerly to Arrastra Creek Valley, the old Morongo Mine to the summit of the range dividing Bear rom Arrastra Valley; thence westerly along said summit to the head f Crystal Creek; thence northerly to the place of beginning.

Trojan Mining District

ses principally that section lying within the following limits: ncing at northwest corner of Section 34, Township 9 north, Range running north eighteen miles; thence east twelve miles; thence ghteen miles; thence west twelve miles to the place of beginning. strict has recently been subdivided into three mineral districts: ld Belt District, on the west of Providence Mountain; the Arrow District, on the south of Providence and east of Old Dad Mount- Trojan Mining District proper, the remainder.

Silver Mountain District

Is generally known as Oro Grande District, and commences at the old Stoddard Crossing on the Mojave River; thence east to Rabbit Creek; thence north to the old Panamint Crossing of the Mojave River; thence northeast to Cottonwood Station; thence west to the county line; thence south to Rock Creek Cañon; thence to the place of beginning. Commences at southwest corner of Township 4 north, Range 3 west; thence northeasterly to northeast corner of the northwest quarter of Township 4 north, Range 1 east; thence northwesterly to northeast corner of the southeast quarter of Township 8 north, Range 4 west; thence northeast to the southwest corner of the southeast quarter of Township 9 north, Range 3 west; thence west to San Bernardino County boundary line; thence south five townships; thence east to the place of beginning.

Lava Bed District

Comprises Township 7 north, Range 4 east, and Township 7 north, Range 5 east.

Alvord District

Is bounded on the west by Calico District, south by the Mojave River, east by Bitter Springs, north by Paradise Valley and Dry Lake. It is fifteen miles square. Commencing at the southeast corner of the southwest quarter of Township 10 north, Range 2 east; thence to the north boundary of Township 13 north, Range 2 east; thence east eighteen miles; thence southeasterly to southeast corner of the southwest quarter of Township 11 north, Range 6 east; thence along the Mojave River to the place of beginning.

Calico Mining District

Comprises Township 10 north, Range 1 east, the south half of Township 11 north, Range 1 east, and west half of Township 10 north, Range 2 east. Commencing at a point two miles and one half west of the Waterloo Mill or Little Red Butte; thence ten miles north; thence ten miles east; thence ten miles south; thence ten miles to the place of beginning.

The Clark District

Comprises the following area: Commencing at the southwest corner of Township 16 north, Range 12 east; thence north three townships; thence east to State line; thence along State line to the northeast corner of Township 17 north, Range 15 east; thence south two townships; thence west four townships to place of beginning.

The Scanlon Mining District,

Recently formed, is situated in Old Woman's Mountain, and is four miles wide by six long.

BUILDING STONE, ETC.

Granite.

The Shearer Quarry is two miles and a half north of Victor, on the east bank of the Mojave River. This quarry produces a fair quality of granite. Where it has been opened, the face is fifty feet in height and seventy-five feet in width. The rock is bluish in color, and in texture, fine-grained.

Dimension stone can be quarried in blocks four feet square, or larger, if so desired. Twelve men are employed, and operations have been carried on for eighteen months.

The St. John's Quarry, half a mile south of Victor, owned by the Hesperia Land and Water Company, of Los Angeles, furnishes a good quality of granite for building purposes. It is of a grayish-blue color, very hard and compact, straight and smooth cleavage, dresses well, and takes a fine polish. The granite formation in which it is found rises to a height of two hundred feet above the Mojave River. Stone from this quarry is used in San Francisco for building, curbing, and street paving; also in Los Angeles, San Bernardino, and other cities and towns in the State. It lies in strata of great thickness. The overlying stratum has been opened for a length of seven hundred feet, and to a depth of fifty, on both the east and west sides of the ridge. The stone in the eastern development is less seamy than that in the western part, and generally of much better quality. A block recently taken from the east side workings measured nine by thirteen by sixteen feet. The strata dip easterly at an angle of 14 degrees.

Sandstone.

The Southern California Sandstone Company has opened a quarry and erected a mill at a point twenty miles north 70 degrees east from Colton, in the Yuciepa Mining District, above the mouth of Mill Creek, in Section 7, Township 1 south, Range 1 west, San Bernardino Meridian. The strike of this stone is northwest and southeast, dip 30 degrees southwesterly. It consists of two varieties, one hard and fine grained, the other a yellow, soft and coarse. The rock cleaves straight, dresses well, and can be quarried in blocks of any dimensions.

Lime Quarries Recently Opened.

Extensive quarries have recently been opened on a blue limestone belt situated in the Oro Grande Mountain Range. For the reduction of this stone eight kilns have been constructed at Oro Grande with a capacity of four hundred and fifty barrels daily. The stratification of the quarries is from northeast to southwest. Thirty men are employed at present, and the production of lime amounts to one hundred barrels per day. The subsidence of the building "boom," as the excitement was called in the southern part of the State, has materially decreased the demand for lime. The quarry is two hundred and fifty feet long, one hundred feet wide, and sixty feet in height.

Borax.

Extensive borax fields are worked in Death Valley, on the Amargosa River, by W. T. Coleman & Co. Searles Brothers own and work borax beds lying south of the Inyo County line, and south of the Coso Mountain Range. The material is found on the borders of a dry lake, ninety-six square miles in area. Colemanite is also found in San Bernardino County, in the Calico Range of mountains, near Daggett, also in small quantities in other localities; in places occurring in a bedded form, similar to that of a coal measure, dipping into the hill in which it occurs at an angle of 36 degrees, lying between walls of a dissimilar character, and would easily be mistaken for a true vein or a contact deposit, were it not for the surroundings and fossiliferous remains found in the underlying strata. This deposit is from four to nine feet in thickness, very regular in its deposition, with smooth walls.

GOLD MINING.

Following are brief descriptions of the various gold mines in the county:

Gold King.

Quartz; situated in the San Gabriel Range, Section 22, Township 2 north, Range 6 west. Scarcely any development.

Short and Ross.

Quartz; situated ten miles below the head of San Gabriel River. Vein twelve feet wide, with a shaft twenty feet deep. A mill is being built.

Ord Mines.

Quartz; situated in the Ord Range. The veins or lodes lie at an altitude of four thousand five hundred feet above sea level, and the mines are distant from Daggett about fourteen miles, or nine miles in an air line through the Ord Range of mountains, and course for an uninterrupted distance of four miles, on which fourteen full locations of one thousand five hundred feet each have been made. The northerly end of this lode contains copper as well as gold, while six of the southerly locations are strictly gold-bearing, the rock from which carries from $7 to $9 per ton. At and near the surface the ores are free milling, but as depth is reached sulphides of iron and copper appear. The vein is well defined, and dips easterly at an angle of 70 degrees.

The ore shoots are several hundred feet in length (four hundred feet in the Conpure), and have a southerly dip. Width of vein from four feet to one hundred (average, forty) in most of the mines. In the Conpure, as proved by crosscuts, it varies from sixty to one hundred feet. The vein can be undercut one thousand five hundred feet in length, giving backs of eight hundred and fifty feet. Southerly, the gold-bearing veins vary from eight to twelve feet in width.

There are good roads to the district, and both water and fuel are obtainable within reasonable distance.

The Black Hawk Mines

Are situated in the district of the same name, fourteen miles from Rabbit Springs by road, or eight miles in an air line, in the Black Hawk Mountains, a spur of the San Bernardino Range. The trend of the chain at this point is easterly and westerly. On the northerly and easterly flanks, fronting the desert, a belt of limestone occurs, extending on the line of strike for ten miles, and from four to six miles wide. It is bounded by the desert on the north and east, and on the west by granitic rocks. It is in this extensive lime belt that the Hecla, Calumet, Lady Alice, and Santa Fe locations are made, at a height of six thousand and fifty to six thousand seven hundred and fifty feet above sea level. They lie on a foot wall of micaceous slate, which is underlaid, in turn, by syenite, dipping into the hill southerly at an angle of 45 degrees. The elevation of Cushingbury is four thousand and eight feet; elevation of the mine, five thousand five hundred and sixty feet at its lower workings.

The Rose Mine

Is located in the Morongo Mining District, southwest from Cushingbury, *fourteen miles* distant, at an elevation of seven thousand two hundred and

fifty feet, and near the head of Rattlesnake Cañon, which empties into the desert, ten miles southwest from the settlement named above. This is a vein carrying much iron, and is four feet thick. Its strike is north 20 degrees west, and is inclosed in walls of micaceous and talcose slate. There is a shaft here one hundred feet deep. The croppings are traceable four thousand five hundred feet, and the rock shows free gold, reported to assay from $5 to $110 per ton. In the vicinity of this mine there are several small veins, rich in gold, worked by Mexicans. At a point about four miles easterly from a mine called the Morongo King, a vein of quartz crops out boldly and heavily, but it is bunchy and spotted. It strikes northeast and southwest and dips northwesterly. The mountain, where it is found, is composed of granite, micaceous slate, and quartzite.

Side Winder.

This mine is situated in Highland Mountain, at an elevation of three thousand eight hundred feet, five miles southerly from Stoddart's Wells, twenty miles south of Daggett, twelve miles east of Oro Grande, and twelve miles north of Victor. It is in the Silver Mountain Mining District (unsurveyed land), and has a metamorphic slate hanging wall with a syenitic foot wall. The vein crops for a distance of three thousand feet, and the value of the ore per ton is reported to be $25 to $50. This mine has an inclined shaft one hundred and twelve feet deep, the dip being 35 degrees, a drift eighty feet long, and several openings and shafts on the lode line for fifteen hundred feet. A drift two thousand feet long on the lode would give five hundred feet of backs.

The Sparkhule Mine

Is situated in Central Camp, Silver Mountain District, twelve miles west of Oro Grande. The vein is reported as carrying from $8 to $90 per ton in gold and silver, the latter in larger quantity than the former.

Imperial Mine

Is located nine miles westerly from Victor, also in the Silver Mountain District. The walls of the vein are granite, and the gangue quartz; width of vein from seven to ten feet; it will yield about $9 per ton. The vein is traceable one thousand feet in a northeasterly course.

The Oro Grande Mine

Is situated in the mountain of the same name, and in Silver Mountain District, at an elevation of three thousand seven hundred and fifty feet. The gangue is quartz, laminated, and with a clay gouge on both walls, which are porphyry and granite.

A well timbered shaft, two hundred and fifty feet deep, with the proportions six by nine feet, has developed the mine to that extent. There is also another shaft (No. 2), one hundred feet from the first, which has been sunk fifty feet, and shows two feet of quartz. The quartz in this mine carries pyrites, and is reported to yield $12 per ton in free gold.

The remoteness of the Oro Grande property from water, however, and the cost of transportation, compelled the company to stop work, notwithstanding they owned a good ten-stamp mill in connection with the mine.

The Oro Fino.

This property is situated in Silver Mountain District, ten miles from Oro Grande, at an elevation of three thousand seven hundred and ninety feet. The strike of the vein is east and west, and the formation feldspathic granite. The lode is from six to twenty inches wide, and carries high-grade gold rock. The mine lies idle.

The Whatnot Mine

Is situated on Whatnot Hill, in the Oro Grande Range, Silver Mountain District, three miles and a half easterly from Mojave River. The vein strikes north and south, with a width of from ten to twelve inches; the gangue is quartz. It is developed by a tunnel three hundred feet long on the vein, with shafts to the surface, and some winzes and crosscuts. The vein is spotted, and occasionally rich, the assays being $60 in gold and $20 in silver, per ton. Syenite forms both foot and hanging walls.

[From the northeastern portion of the county many recent gold discoveries have been reported, but as yet have not been visited by the Bureau's assistants in the field.]

SILVER MINING.

The Morongo.

This mine is located ten miles southerly from the Black Hawk, at an elevation of six thousand three hundred feet, in Bear Valley Mining District, Black Hawk Range of mountains, six miles east from the valley. Strike, north 70 degrees west; formation, lime shale; gangue, quartz. A streak of ore follows the hanging wall, with three feet of good ore on the foot wall. Vein sixteen feet thick, with a shaft one hundred feet deep. Drift, ten feet; crosscut, ten feet to foot wall. The lode dips northeast 55 degrees. One hundred feet westerly a shaft is sunk twenty feet, exposing ten feet of ore mixed with waste, with two feet of the ore on the hanging wall; thence one hundred feet westerly, the vein is cut off by a cross course. Much work has been done on this mine, with, as yet, but little result.

The Silver Belt.

This mine is located in Galena Camp, Silver Mountain District. It shows a vein of lead ore, carrying thirty-four ounces of silver to the ton, and $9 in gold. Vein twelve inches thick; little development.

North Camp

Lies seven miles in a southwesterly direction from Oro Grande, in a low range of light-colored hills, with a dolomitic limestone formation. It has the following veins:

Lillie.—Strike, north 20 degrees west; dip, southwest 75 degrees; gangue, quartz; formation, magnesian limestone. Ore, bunchy, but rich, and assays two hundred and thirty-four ounces in silver. Vein thin.

Pontiac.—A two-foot vein carrying brittle silver and chlorides; formation, dolomite. This vein is traceable for one mile and a half on its line of strike; gangue, quartz. Numerous feeders of high-grade silver ore lead into this vein. There are, it may be added, quite a number of small veins, varying from inches to feet, coursing through the hill in a northerly and southerly direction, and carrying very rich ore, such as the Golden Heaven,

len Chord, Little Turtle, etc.; but scarcely any work has been done em.

A Group.

ne north side of North Camp Mountain, twenty miles from Oro , occurs a group of silver-bearing veins, with quartz gangue. These e in a dolomite formation, and have an easterly and westerly strike. p Springer and Cornet are the most prominent in value among the s.

West Camp

lver Mountain District, twelve miles westerly from Oro Grande, in ountain range composed for the most part of magnesian stratified ne, syenite, and porphyry, through which runs, in a northwesterly theasterly direction, a strong, well defined vein, carrying gold, sil- l lead. The most marked and persistent in the line of strike are ations known as Twenty-Nine, The Stranger, and The Clincker

ty-Nine has a three-foot vein, rich in silver; strikes northwest and st; walls, blue limestone on the east and dolomite on the west. in is highly mineralized.

ker No. 1 has been developed by two shafts, respectively sixty and ve feet deep, and lying six hundred feet apart.

ker Nos. 2 and 3 are parallel veins, lying three hundred and fifty terly from No. 1.

Side Issue lies parallel, three hundred and twenty-five feet west of ncker vein. It is from one to three feet in width, and is developed nclined shaft sunk in dolomitic limestone. The ore is a copper tance. Strike of vein, north 10 degrees west.

The Commercial

from two to three feet of a vein lying parallel with the Side Issue, ich crops for fifteen hundred feet. The vein lies between porphyry estone. The ores carry copper and silver.

The Capital

) hundred feet easterly from the Commercial, and courses northerly therly. Vein from three to twenty-six feet wide; ore averages fif- nces in silver to the ton; developed by Shaft No. 1, fifty-five feet nd Shaft No. 2, sixty-nine feet deep. The vein is inclosed in a for- of porphyry and stratified limestone, and is traceable on its line of r six thousand feet. Water can be obtained from Dry Lake, one d a half distant, in any quantity desired.

The General.

mine lies on the west side of West Camp Mountains, in the vicinity Lake, and is six miles east of the Los Angeles and San Bernardino line. It is developed by a shaft seventy feet deep.

The Boss Mine

vicinity. It courses north and south; gangue, quartz. The vein two to eighteen inches wide; formation, blue limestone on the east phyry on the west; strike, north 20 degrees west. Ores carry gold 'er; assays vary from $20 to $72 to the ton.

Central Camp

Is situated in a distinct and separate hill or eminence lying midway between the Galena and West Camps, in Silver Mountain District. The veins are strong, and lie between limestone on the east and prophyry on the west, varying from five to ten feet in width. Development is by a shaft fifty feet deep, with several shallow pits on the line of the lode.

The Blue Jay, or Homestake Mine,

Is located in Silver Mountain District, four miles easterly from Oro Grande and ten miles northwesterly from Victor, at an elevation of three thousand seven hundred and fifty feet. The formation is syenitic, porphyritic, and calcareous; strike, easterly and westerly, dipping south 45 degrees; vein, four feet thick; ores, copper and silver. The mine is developed by a sixty-foot shaft and a forty-foot crosscut, all in ore that carries forty-seven ounces of silver to the ton. Vein has a porphyritic foot wall and limestone hanging wall.

The Blue Jacket

Is located in the Oro Grande Range of mountains, at an elevation of three thousand three hundred feet above the level of the sea, three miles and a half east of Ore Grande, in Mineral Hill. Formation, dolomite; strike, northeast and southwest; vein, eight feet wide, quartz and calc spar inclosed in dolomitic walls, with a strike north 10 degrees east; minerals, iron, copper, and silver. The mine is developed by a shaft forty feet deep, all in ore of good character. An eighty-foot shaft has been sunk one hundred feet southerly, and the vein shows a width of eight feet; ore friable. At this point a strong vein eight feet wide enters from the west. The ores from this mine were reduced at the Oro Grande Mill, with unsatisfactory results, owing to their rebellious character; they are rich in silver, but base. After the ore was worked operations ceased, and have been suspended for three years, with the exception of the necessary assessment work to hold the claim.

The Carbonate Mine

Is also located near Oro Grande, in the Silver Mountain District. Though classified as a lead mine, and carrying carbonates with a high percentage of both silver and gold, it is entitled to a place under the head of "Silver Mines," as it assays fifty ounces per ton of silver. For particulars of development, see "Lead Mines."

Lava Bed District

Is in the Lava Bed Range of mountains, an easterly extension of the Ord Range, south 80 degrees east from Daggett, twenty-six miles by wagon road, and at a point nearly opposite Lavic Station, on the Atlantic and Pacific Railroad.

Its formation is syenitic and porphyritic, and where showing stratification, coursing north 22 degrees east. Highest altitude of mountain, four thousand one hundred and seventy-five feet. The aneroid shows, at the base, an elevation of two thousand one hundred feet. In this mountain there are several powerful veins cropping boldly, and for long distances, to heights varying from ten to fifty feet, and traceable for more than a mile on their line of strike.

The Pequod

ιis district has a strong vein, but little developed.

The Tip Top

at an elevation of three thousand seven hundred feet. Strike of vein, ι 70 degrees west; dip, northeasterly 45 degrees. The vein is ten feet , showing a dark ferruginous ore, carrying gold. Eighteen assays gave verage of $24 50 per ton.

The Everett Mine

at an elevation of two thousand nine hundred and fifty feet. The vein s a width of eighteen feet, four feet of which assay seven ounces of r to the ton; nine feet barren, and five feet ore next the hanging wall. e is a shaft sixty feet deep; west drift, thirty feet; east drift, twenty-feet. Walls smooth and well defined.

Mammoth Mine,

g in Lava Bed District, has a strike north 70 degrees west; dip, south egrees. The vein is banded, with four feet of good ore on the south It is from twenty to forty feet wide, and crops out boldly the full h of the claim. Ores, carbonate of lead, galena, and silver. In an rly direction, up hill, the croppings are also prominent, but the vein nsiderably disturbed and broken, volcanic matter appearing instead ıartz. At an elevation of three thousand three hundred and seventy-feet it resumes its proper shape. The shaft is twenty feet deep, and re assays (as reported) ninety-five ounces of silver per ton. On the nit, at an elevation of three thousand four hundred and fifty feet, a y-foot shaft exposes a vein twenty feet wide, carrying considerable ta. Ore said to assay from fifteen to twenty ounces per ton.

The Meteor Mine

ı extension of the Mammoth, where the vein, nine feet thick, crosses ine; dip, south 80 degrees; croppings bold; ore said to assay twenty es in silver to the ton. Eastwardly the ledge increases in size to ty feet, composed of quartz and a brecciated volcanic mass of rock. ıe center of the claim a crosscut is run through the country rock for een feet. Drift on the lode, thirty-eight feet; shaft ninety feet, with ore on the bottom. The ores are soft carbonates, with bunches of ıa which run high in silver. It is reported that the mine has yielded 00 worth of silver. Two hundred feet eastwardly from the above , a crosscut of forty feet and a drift of the same length have been showing four feet of good ore.

The Morning Star.

ιis mine lies at the extreme easterly end of Lava Bed District, at an ιtion of three thousand and fifty feet, at which point a tunnel has run westwardly on the lode. Strike of lode, north 70 degrees west. crops boldly thirty-five feet in height by one hundred and fifty feet There are four feet of ore on the south wall, said to be good for y ounces per ton. Westwardly three hundred and fifty feet up the at an elevation of three thousand five hundred and fifty feet, Tunnel

No. 1 has been driven on the lode. From a short crosscut, connecting with a shaft seventy feet deep sunk in good ore, some stoping has been done. Two winzes have gone down on ore: No. 1, thirty feet, and No. 2, seventy feet. Tunnel No. 3 runs on the south wall of the vein carrying four feet of poor ore, then crosses at an angle of 18 degrees for one hundred and fifty feet through the vein near the west boundary line. At an elevation of three thousand six hundred and twenty-five feet some good ore in croppings twelve feet thick. Vein twenty feet wide between walls. South of it, two hundred and fifty feet distant, is a spur carrying four feet of galena, but only $7 in silver. Other spurs of galena fall in on the north side of the lode, on one of which an eighty-foot tunnel has been run.

The Rising Sun

Lies parallel with the Mammoth, in Lava Bed District, on the northerly side. Width of vein, eight feet; formation is similar to the Mammoth. The mine is developed by a seventy-five-foot tunnel, and an open cut in the middle of the claim. Assays of the ore vary from forty to fifty ounces of silver per ton. Ore irregular; vein spotted. At this elevation a fine view of both craters, five miles apart, with the old lava flow therefrom, is obtained. Distance to railroad, seven miles. At a dry lake two miles and a half eastwardly from the mines, two wells have been sunk; one sixty, the other ninety feet deep. The supply of water is inexhaustible, but slightly brackish. Elevation of lava mesa, two thousand five hundred and seventy-five feet; diameter of Dry Lake, east and west, five miles; elevation, one thousand nine hundred and twenty-five feet. Elevation of Warm Springs Lake, twenty miles westwardly from the mines, one thousand nine hundred and twenty-five feet.

The ores of zinc and antimony, carrying silver, abound in many parts of the county.

COPPER MINING.

Veins of cupriferous ores are found in Ord Mountain, in the Ord Mining District. Elevation of the mountain above tide-water is four thousand five hundred feet. It is easily accessible by wagon road already built to Daggett, fourteen miles northerly. The veins mentioned course northerly and southerly, with a dip 70 degrees easterly. They are inclosed in walls, differing in formation, and which sometimes have a clay gouge. The veins carry copper and gold.

The copper ores are carbonates, oxides, sulphides, and metallic copper. The latter lies in a formation of clay, eight to ten feet thick, adjoining the lode proper.

The roads to Daggett are smooth, and of easy grade. Ores can be hauled by contract to that place, from any of the mines, for $1 50 per ton. Water can be obtained in Daggett free of cost. Coal costs $9 per ton. The mines can be opened by an adit driven on the vein, giving a vertical depth of eight hundred feet of backs.

At Old Woman's Springs,

Near Morongo Pass, in the Morongo District, copper veins are found, carrying gold.

In Clark District

The Copper King Mine is located. The foothills of the Colorado River Range of mountains, near the river of the same name, have been cele-

brated for strong veins of high-grade copper ores, and they also occur near the Ibex Tank and Sacramento Springs, nine miles westerly from the middle of the Colorado, and in the foothills of Big Timber or Charleston Range of mountains.

Near Good Springs rich deposits of copper are also found.

Copper is also met with fifteen miles southeast of Ord, and fourteen miles northeast of Old Woman's Springs. Formation of walls, slate and limestone. Developed by shaft sixty feet deep, showing a four-foot vein, the ores of which are principally sulphides.

LEAD.

Lead is found in Rattlesnake Cañon, Morongo District, four miles east of the Rose Mine. Here the Lawrence Mine is located. The formation is granite and micaceous slate, and the vein is four feet in width; strike, north 80 degrees east. Galena is the character of the ore, developed by a forty-foot shaft and an open cut.

The Morongo Mine

Is in Bear Valley District, and carries four feet in width of argentiferous lead ores. Silver lead ores also occur at other points on the southerly edge of the lime belt adjoining the granite, which forms the axis of the Bear Valley Range. Little work has, however, been done upon them. The ores carry from five to twenty ounces in silver per ton, and from $9 to $10 in gold. The Colorado Mine is in this formation, with a shaft down seventy-five feet, and a drift of forty feet, showing four feet of ore containing some carbonate of lead and galena.

Galena Camp

Lies in a low range of hills, south 70 degrees west from Oro Grande, which is seven miles distant. The hill inclosing the Lucky Tom, Nos. 1, 2, and 3, is one mile long and three thousand feet in width. The vein is twenty feet wide. Strike, north 20 degrees west. Hanging wall, stratified limestone; foot wall, syenite. The ores are silver-bearing carbonates of lead and galena, developed by a twenty-foot shaft.

The Silver Belt

Lies one mile northerly and runs parallel with the Robin Hood vein; but little developed. It shows a width of twelve feet, and carries gold and silver as well as carbonates of lead and galena. The veins are from three to fifty feet in width. They are in limestone.

The Harrison Mine

Is located four miles and one half northeast from Oro Grande. The vein is five feet in width, with walls of blue limestone. Ores, galena, and zinc blende carrying silver; but little development has been made, owing to the want of a smelter in the vicinity.

The Carbonate Mine

Is in limestone, and lies two miles east of the town of Oro Grande, on the western slope of the Oro Grande Mountain.

The vein underlies a body of blue limestone, remarkably pure. The property is in course of active development by a full force of miners.

Strike of vein, north 80 degrees east, dipping north at an angle of 45 degrees; it varies in thickness from eighteen to twenty-four feet.

Adjoining this vein, twenty-five feet distant, a parallel vein of the same character occurs, on which an eighty-foot inclined shaft has been sunk, at the bottom of which the ore is said to assay one hundred and forty ounces of silver, $16 in gold, and 40 per cent of lead. Another shaft, one thousand feet distant, has been sunk to a depth of one hundred feet; the ore is reported to assay 57 per cent lead and six ounces of silver.

The Stonewall Jackson

Lies six miles northwesterly from Barstow, and in the vicinity of the Waterman Mine, in the Grapevine Mining District, four miles and a half northeast from Hinckley Station, on the Atlantic and Pacific Railroad. Elevation, two thousand two hundred and twenty-five feet. Strike of vein northwest and southeast. Developed by an inclined shaft thirty-six feet deep; dip of lode for twenty-eight feet, 40 degrees; for eight feet, 60 degrees; thickness of vein at bottom of shaft, eight feet; ores, oxides of iron and carbonate of lead. There are a number of locations on this vein.

The Beauregard

Is located on this vein. Elevation, two thousand one hundred and fifty feet, with a northwesterly strike; same character of ore in crosscut. The vein shows a width of ten feet, with hanging wall not reached; dip, 45 degrees.

Next adjoining claim northwest on the line of the lead is the Honeycomb. It runs seven hundred and fifty feet northwest and southeast of the discovery shaft, which is nine feet deep and twelve feet wide.

Next claim northwest is the No Name. Elevation, two thousand one hundred and thirty feet; shaft, thirty-five feet deep, all in ore (iron oxide and carbonate of lead with copper stains). Another shaft is sunk about two hundred feet distant to a depth of forty feet. Inclination of lode, 65 degrees.

The Ventura Claim comes next. Elevation, two thousand one hundred feet. Shaft, sixteen feet deep; four feet of ore of the same character as that in the Honeycomb Mine.

Next location is called the Jupiter. Elevation, two thousand one hundred feet. Shaft, eight feet. Vein dips at an angle of 60 degrees east. Same character of ore.

The Cleaveland Mine

Is located on a lone mountain near the boundary line separating the Calico from the Grapevine Mining District; distant five miles northwest from Daggett, and four west from Calico. The mine is in Grapevine District. It has been developed by an inclined shaft one hundred and seventy feet deep on a dip of 35 degrees east. The ore body exposed is fourteen feet wide, the richest portion being on the foot wall; carries some silver. Hanging wall porphyry; foot wall a decomposed feldspar. Average value of the above described ores, treated at the Selby Smelting Works, San Francisco, as a test, 26 per cent lead and twenty ounces silver.

The Cuticura

Adjoins the Cleaveland, and runs parallel with it on its westerly boundary line. The formation is calcareous rock, much changed. Strike of the vein is northwest and southeast, dipping northeasterly at an angle of 60 degrees.

Gangue, siliceous; ores, carbonate and oxide of lead, bearing silver. Vein four feet wide between well defined walls of lime and quartzite, developed by a sixty-foot shaft and several surface crosscuts.

The Midnight

Is on the same vein, being the easterly extension of the Cuticura. It is traceable its entire length of fifteen hundred feet, and shows the same class of ores. Slight development.

The Harrison Mine

Is located in Silver Mountain District, three miles and a half easterly from Victor Station, on the California Southern Railroad. It is in a limestone belt. Width of vein, four feet; strike, north 20 degrees east; ores, zinc and lead, carbonates and sulphides. Large deposits of silver-lead ores are said to exist at other places in San Bernardino County, and in other counties tributary to it, particularly at Resting Springs, Solo District, Five Points, Good Springs, Old Woman's Mountain, and New York District.

IRON, MAGNETIC AND HEMATITE,

Is found in Lava Bed Mining District, Sections 27 and 28, Township 6 north, Range 4 east, S. B. M. Two massive veins occur on the southerly slope of the range of mountains in this district, a southeasterly prolongation of the Ord Range. The range proper, last named, is about thirty miles long from its extreme southeasterly to its northwesterly point.

The place known as Iron Mountain, where these immense deposits lie, is situated about eighteen miles southerly from Newberry Station, on the Atlantic and Pacific Railroad.

The Lava Bed Range of mountains is entered on its northern border through a narrow gorge. The rocks on both walls of this pass are jagged, sharp, angular, and black, and stained by the oxides of iron. At the entrance this defile is fifty feet in width by two hundred feet in height, vertical in places, in others slightly inclined. Passing in for four hundred feet, an amphitheater is reached, which possibly may have been a volcanic crater. This space is surrounded by rock of the same character as on the walls of the pass or gorge. Thence, in a southerly direction for five miles, volcanic rocks, tufa, and sandstones of volcanic material are found. Reaching the summit, at an elevation of three thousand eight hundred and eighty feet, all traces of volcanic action have disappeared.

The rocks are granitic in character on the southerly slope of the mountain and at its base. At an elevation of three thousand and twenty-five feet is found the iron deposit under consideration, eight miles from the summit. The mines are named: Dick Turpin, Nos. 1 and 2; Tip Top, Nos. 1 and 2; and Bessemer, No. 1.

These veins are well defined, with dissimilar walls, and with a selvage, or, as more commonly called, a clay gouge. They course north 20 degrees east, and dip into the hill northwest, at an angle of about 30 degrees.

The Tip Top and Dick Turpin are separated by one hundred and fifty feet of syenite, and lie nearly parallel, continuing in their southerly course at a small angle of inclination. The Turpin ores are remarkably pure, and highly magnetic. The Tip Top is the northerly vein, and lies at an elevation of three thousand two hundred and five feet. The vein is composed of hematite and magnetic iron, with a gray, soft material known as

nut ore. It courses north 70 degrees west. Its northern wall is an irregular belt of dolomitic limestone; the southern, syenite.

At this point the vein is thirty feet in width, increasing in strength to one hundred and fifty feet, as the hill is descended four hundred feet.

The ore occurs as a defined vein in place, not in beds, as usual. The dolomitic formation that bounds the Tip Top, on the north, is irregular in form and strike, and is, in turn, bounded by the granitic rocks, a prolongation of the Ord Mountain Range.

The strike of the Bessemer No. 1 is due north and south, and it also shows a strong body of magnetic ore, reported free from phosphorus and sulphur.

This mine has been but little developed. Some small pits and a ten-foot shaft are the extent of the work.

The ore body is traceable from its northeasterly exposure, at an elevation of three thousand three hundred and fifty feet, in a southwesterly direction, through the low foothills, at an elevation of three thousand and twenty-five feet, for a length (on the line of the strike) of three thousand two hundred feet, with an average width of eighty feet, widening in places to four hundred feet.

Four miles southeasterly from this point, and on the same mountain range, an extensive body of highly magnetic iron ore occurs, the maximum width of which is one hundred feet; the minimum, twenty; course and strike of vein, same as above.

Kingston Mountain and Resting Springs are also reported to contain magnetic iron, as well as many other places in this county.

ZINC.

The Harrison Mine, described under the head of "Lead Properties," and situated three miles and a half from the town of Victor, carries an ore body of four feet in width, stated to assay 27 per cent zinc.

ASBESTUS.

The mine known as "The Scorpion" consists of two locations. It is situated in the low range of hills two and a half miles westerly from the Mojave River, and fourteen miles northerly from Rio Grande.

AURIFEROUS GRAVEL,

Of the San Gabriel Range, etc.

On Lytle Creek, thirteen miles northwesterly from Colton, auriferous gravel is found. From the mouth of the cañon northerly, five miles, to Pratts, there is more or less of it, and considerable work was once done here. The available places, however, are nearly exhausted, and work has been discontinued for a long time. . At Texas Point some $80,000 is reported to have been taken out by hydraulic process. Above this point the ravine spreads out in flats, covered by large granite bowlders.

Crossing the ravine near Glenn's ranch, Township 2 north, Range 6 west, Section 22, a vein of gold-bearing rock occurs, which give a good horn-spoon prospect, showing free gold; but no work has been done on it, other than sinking a five-foot shaft. Near this place is a thermal spring, with a temperature of 95 degrees. Elevation, two thousand six hundred and five feet above sea level.

On the headwaters of the San Gabriel River, close to the line on the Los Angeles side, and westerly from the point above mentioned, ten miles from its source southerly, and thirty-five miles westerly from Glenn's ranch, on the western slope of the San Gabriel and Lytle Creek Ranges, lies the San Gabriel Gold Mine.

A shaft twenty feet in depth has been sunk, exposing a vein twelve feet wide, and a quartz mill is being built on the property. The ore is said to yield $12 per ton.

Wood is abundant. With a good water power, low grade ores found in this vicinity can be handled at very small cost per ton, and made to pay a handsome profit.

On the northern slope of the San Antonio Peak, at an elevation of eight thousand one hundred and forty feet, a dead river channel of auriferous gravel was discovered in the summer of 1882. In many respects this gravel resembles that of the pliocene beds so extensively worked in the middle and northern counties of California. The gold is nine hundred fine. This range is being developed by three companies, each owning one thousand five hundred feet of ground.

The Bald Mountain Gold Mines are in successful operation. Width of channel (ascertained by crosscut), two hundred to two hundred and fifty feet. Its course is northwest. The present workings are on the westerly rim of the channel.

Water is obtained from melting snows and caught in reservoirs of small dimensions. It is used under a three hundred-foot pressure-head through a six-inch pipe, with two and a half by three-inch nozzle.

The season is necessarily short, commencing in May and ending in November. The gravel first passes over a grizzly, then through three sixteen-foot boxes, sixteen inches wide and twenty-four inches deep, set at a sixteen-inch grade to the box. Quicksilver is not used in the boxes or ground sluice, but in the under-currents; cross rifflers, two by four, are used in the boxes, set at a sharp angle, one inch and a half apart.

The mine is only worked by day, but the yield is reported at $8 daily to the hand. Six men are employed.

At the head of the San Gabriel Cañon, in Los Angeles County, northwesterly from this point and at about the same elevation, the same character of gravel is seen.

The gravel banks on the San Gabriel River are known to be rich, and several companies were formed to work them; but for some reason all the projects fell through. At one time an English stock company was organized for this purpose, but called a halt after incorporating and selling a few shares of stock.

At a point on the eastern terminus of the Bear Valley Range (a spur of the San Bernardino Range), near the mouth of Cook Cañon, gold placers have been worked by dry washing for many years. At present they are still operated to a limited extent by a few Mexican miners. The ground is extensive and rich, but no water has ever been taken upon it. It is reported that $8 per day to the hand is not an unusual yield.

MILLS AND REDUCTION WORKS.

Oro Grande

Contains one ten-stamp mill erected by the original Oro Grande Mining Company. It first dropped stamps in 1878, on ores from the Silver Mountain Mining District. Subsequently it was sold to the company still retain-

ing the name, but their operations are now carried on in Calico District, and the Oro Grande Mill lies idle.

Daggett.

In the town proper there is a good five-stamp custom gold and silver mill, but worked irregularly. It was erected in 1885. This mill, it is expected, will be kept constantly employed during 1890 on custom ores from outside districts. Daggett has also a sampling plant lying idle. The Waterloo Mill of sixty stamps, and the King Mill of fifteen stamps, both belonging to the Oro Grande Mining Company, are located on the banks of the Mojave River, one mile in a northerly direction from Daggett. The mill last named was erected in 1882, and has been constantly in operation since that time. The Waterloo was completed in 1888, and is kept steadily at work on ore from the mine that bears its name.

A large area containing valuable mines of gold, silver, lead, and copper lies within a radius of one hundred miles, and would naturally be tributary to Daggett, or some other central point where suitable reduction works could be erected on an extensive scale.

Waterman.

This two-stamp mill was built in 1881, and after running for six years, has lain idle since 1887.

Camp Cady

Is an old Government military post, twenty miles easterly from Daggett, and has a five-stamp gold mill, which is occasionally run on ore from the Alvord Mine, some nine miles away in a northerly direction.

Holcomb Valley.

At this place a five-stamp gold mill is kept constantly at work on custom ore during the summer months.

Ivanpah.

Here there are two mills, with respectively five and ten stamps each, employed in reducing ore from the Clark Mining District.

Providence (Trojan District).

At present there is but one five-stamp mill at work here on the ores from the Perseverance Mine. The ten-stamp mill of the Bonanza King, destroyed by fire in 1887, has never been rebuilt.

Rattler District.

The Virginia Dale Mining Company of San Bernardino County erected a five-stamp mill upon their property in 1887. The cost of mining and milling was too heavy, however, and operations were suspended in 1889. This property is situated about thirty-four miles south from Cadiz, a station on the Atlantic and Pacific Railroad.

Ibex.

A five-stamp mill with this name is located almost on the boundary line *between* San Bernardino and Inyo Counties, on the east side of Death

Valley, six miles northwesterly from Saratoga Springs, and thirteen miles westerly from the Amargosa Borax Works. It has been running occasionally during the past two years on ore from a mine of the same name. That it is not run constantly is owing to a lack of fuel. The mine and mill are owned by a Chicago company. [This property must not be confounded with the Ibex Gold Mines located near Ibex Station, on the Atlantic and Pacific Railroad, nine miles west of Needles and the Colorado River.]

Rincon.

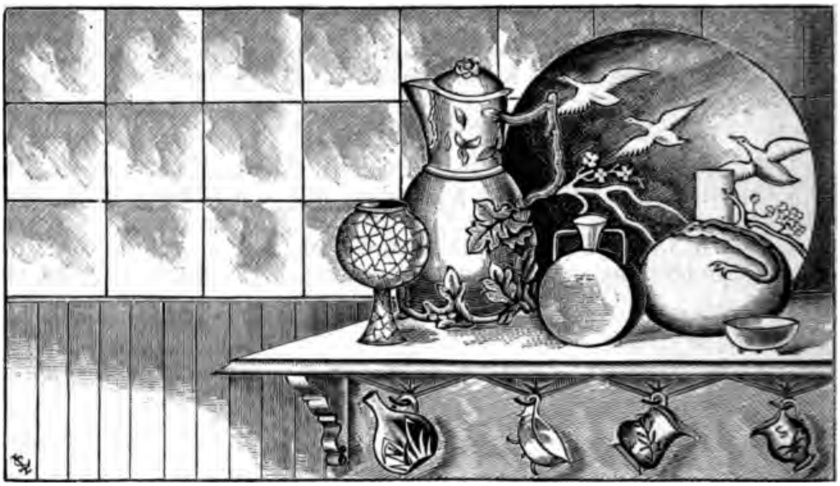
This ten-stamp mill was built upon the banks of the Colorado River, about fifty miles below The Needles, in 1887. It ran but a short time, and is idle at present.

Resting Springs and Tecopa

Are both situated near the line that divides California from Nevada. At the place first named there is a ten-stamp mill, and at the second three water Jacket furnaces. This machinery was kept in operation for several years; but in 1882 the lack of fuel caused a suspension. Since that time no work has been done. Constant prospecting of the mines is going on, however.

POTTERY.

By Linna Irelan.



The expression "Pottery" embraces a large scope and covers a wide field; it will therefore be impossible to do entire justice to the subject in a short article. The following will consequently be in reality merely a sketchy description of pottery and its decoration. It must be impressed upon the mind that "pottery" is simply a general name for articles made or modeled from clay and baked. It may be divided into two distinct classes: *terra cotta earthenware* and *porcelain*. The former includes anything in the shape of vessels made of clay, beginning with the cheap and unassuming common flower pot to the most elaborate and gorgeous majolica. The second class, *porcelain*, includes stoneware, which is, in reality, a porcelain of inferior quality, and reaches to the heights of all celebrated porcelains of ancient and modern times. Pottery is classed as *hard* or *soft*, according to the composition, and to the degree of heat which it is exposed to during the process of firing. Common earthenware articles, such as flower pots, cooking utensils, drain pipes, etc., are soft, their characteristics being a softness of the paste or clay, and their ready fusibility if exposed to too high a degree of heat in the furnace or kiln. Softness can easily be recognized by scratching the paste with a sharp instrument, when fine dust will readily crumble off. The so called soft wares are formed into four classes: the unglazed, the lustrous, the glazed, and the enameled. The first three named include the pottery of ancient as well as that of modern times of different manufacture. The latter—the enameled—is covered with enamel composed of feldspathic stone, or quartzose sand, and oxides of tin and lead. This latter class can be decorated in a highly artistic manner.

Among the unglazed pottery we find the common drain pipe, as well as the celebrated delicate terra cotta of Copenhagen, or the elaborate bisques. The glazed ware includes the pretty brown yellow-lined Bunzlau ware for

kitchen use, as well as the famous Doulton, Sèvres, or Meissen, which latter is known by English-speaking nations as Dresden china.

Porcelain has the same characteristics as stoneware, but is of a higher grade, and translucent. As stated before, stoneware is really porcelain of an inferior class. Both have a very high glaze, but can be used unglazed, because they are impervious to moisture. They are both baked at a very much greater heat than earthenware, although some of the fine earthenwares manufactured at the present time require greater heat than formerly, graduating to different degrees, according to the difference in the ware. By carefully comparing broken pieces of the different wares, the layman can easily make a study of the different characteristics, which will prove more instructive than any description. In specimens of the wares belonging to class first, the glaze tells entirely distinct from the body or paste. In class second, it tells as one with the body, so to say, is melted into it.

It has proven a fruitless task to locate the origin of pottery. Chinese traditions teach us that the art of manufacturing pottery was a science with that nation as far back as 2000 B. C. From that period until about 202 B. C., only earthenware was made, but no porcelain. There is hardly any doubt that the Chinese should be considered the inventors of porcelain, and that the expression "China," instead of porcelain, comes from that source; while "porcelain" is derived from the Italian word porcellana, so called after a shell of a beautiful gloss and whiteness (Lypræa porcellana), which the porcelain resembles, and which it was supposed to be made of on account of its fineness and whiteness.

The *classification* of pottery has always been a matter of difficulty, and is necessarily, in spite of the most careful attempts, imperfect to a certain degree, as its origin dates too far back, and dates are too uncertain to complete any work on pottery, etc., without some unavoidable errors occurring.

M. Brongniart, in his "Traité des Arts Céramiques," Paris, 1854, has classified pottery and porcelain, firstly, according to the characteristics derived from the paste, and secondly, as derived from the glaze. His classification is about as follows:

1. Soft pottery, easily fusible:
   (*a*) Biscuit.—Simple baked clay, porous, and without gloss. Example: a common modern flower pot.
   (*b*) Glossy.—Fine clay covered with an almost imperceptible vitreous glaze. Example: most Greek vases.
   (*c*) Glazed.—Clay covered with a perceptible coating of glass. Example: common white earthenware plates.
   (*d*) Enameled.—Clay covered with a vitreous coating, made opaque by white oxide of tin. Example: Italian majolica.
2. Stoneware, very hard and infusible:
   (*a*) Very siliceous clay covered with a lead vitreous glaze. Example: old gray Flemish ware.
   (*b*) Siliceous clay covered with a salt glaze. Example: a modern brown ginger-beer bottle.
3. Porcelain, white, semi-transparent, and only fused at a high temperature:
   (*a*) Hard Porcelain.—Natural kaolinic clay covered with a feldspar glaze. Example: porcelain of China and Japan.
   (*b*) Soft Porcelain.—Artificial paste covered with a lead vitreous glaze. Example: early Sèvres porcelain.

This classification appears incomplete, which is unavoidable, as some pottery really belongs to two classes; for example, Italian majolica, which is enameled and glazed at the same time.

M. Salvétat amends M. Brongniart's classification by making two very complete divisions.

First, *unglazed* or *simple* pottery; second, *glazed* or *composite* pottery. Each of these divisions is again divided into *opaque* and *translucent*. In

opaque potteries there are many very distinct differences. First, the color varies greatly; some are *soft*, some *hard*, and others again *very hard*. These latter form the gradation between soft and translucent pottery. The difference in the temperature forms in some cases the difference in the potteries, so that sometimes the same composition of paste may, at varied degrees of heat, offer the characteristics of all distinct potteries. All translucent potteries have some characteristics in common. They are always very hard, and generally perfectly white.

Porcelain may, simplified, be divided thus:

1. Porcelain—Hard paste.
2. Porcelain—Naturally soft.
3. Porcelain—Artificially soft.

If the paste of hard porcelain is only slightly baked (French: *faible dégourdi*) it is *soft*; when much more baked (French: *très fort dégourdi*), it is, like some earthenware, a hard pottery. When the temperature is just below that which is necessary to soften pegmatite, it becomes stoneware, and last, at a temperature of 1,500 degrees to 1,600 degrees Centigrade (blue white heat), we have procelain, the hardest of all potteries.

To make it an easier task for the layman to grasp the meaning of the different technical terms pertaining to a sketch on pottery, it may be well to give an explanatory schedule of the words used. The simplest manner of doing this will be to arrange an alphabetical list, which is the easiest way to look for reference in pursuing this article.

ADOBE—Sun-dried bricks.

ALBANY DIP—A common clay found near Albany, New York. Used in this country as a black glaze for stoneware.

ARGIL—Clay or potter's earth.

BARBOTINE—Thin slip of paste.

BISCUIT or BISQUE (French)—Term applied to porcelain before it is glazed and when it has no gloss. (German: Matt.) It is porous to a certain degree.

BLUNGER—A wooden blade used for mixing clay.

BONE—Beef bones used to make bone phosphate porcelain.

BORACIC ACID—Mostly derived from borax. Borate of soda, a compound of boric acid and soda. Also biborate of lime.

CAMAÏEU MONOCHROME—Painting in two colors.

CÉLADON—A delicate grayish-green blue; also the name of a glaze on eastern porcelain.

CÉRAMICS or KÉRAMICS—Term given to pottery, derived from the Greek.

CHINA—Porcelain. French: porcelaine. German: porzellan.

CIMENT (French)—By potters called pitchers. Means quartz, sand, calcined flints, calcined bones, chalk, baked clay, or paste, well pulverized.

CLAY—Body for making paste.

CRAZE—Cracking or crackling of the glaze or paint, which is due to the expansion of glaze over the paste. First made by the Chinese and highly valued. Much sought for by collectors.

DUR—French for hard.

DELFT—Delft ware, made in Holland, in the town of Delft. It is a fine earthenware painted and glazed.

EARTHENWARE—French: fayence.

EARTH-ALKALI—Feldspar and other natural glazes; also artificial ones, classed lime-glass glazes. Feldspar is considered a natural glass. Lime, sand (silica) are added as needed. At Sèvres a rock (pegmatite) consisting of a natural mixture of quartz (silica) and feldspar is used.

EGGSHELL—A thin, exquisitely delicate white porcelain highly prized in China.

EGYPTIAN—Pottery made in ancient times in Egypt.

EMAIL—French for enamel.

ENAMEL—An opaque vitrifiable composition used for coating pottery. Also enamel colors.

ENGOBE—A thin layer of paste; a slip.

FAT-OIL—The fatty, thick surface of turpentine.

FAÏENCE (fayence)—French for earthenware.

FELDSPAR, FELDSPATH—A mineral consisting of silica, alumina, and potash.

FLUORSPAR (not feldspar)—Very fusible. Used for glazing.

FLUX—Any substance or mixture used to promote the fusion of metals or minerals, as alkalies, borax, etc.

FUSIBLE—Capable of being melted or liquified. A coating or thin cover of pottery.

GLAZE—To render it impervious to liquids.

Gloss-oven—A kiln in which glazes are baked.
Grounding—Covering pottery with a tint or color. Used in china painting.
Hard (French: dur)—Difficult to fuse or melt. Also means in pottery that it cannot be scratched with a knife or sharp instrument.
Jigger—A wheel used for making flat pieces.
Kaolin—Decomposed feldspar or porcelain clay, from decomposition of granite rocks. (Chinese: kao-lin.)
Kaolin (French)—German, porzellan-erde; porcelain clay.
Kiln—A furnace employed to bake or fire pottery.
Lustres—Metallic, iridescent colors.
Lustrous (French: lustre)—A slight varnish put on pottery.
Majolica—Italian soft, enameled pottery.
Opaque—Not transparent.
Paste (French: pâte)—Body or clay mass.
Pegmatite—A variety of granite; called also graphic granite.
Pitchers—Baked ware finely pulverized. (French: ciment.)
Plumbiferous—With lead.
Plague (French)—Flat or slightly curved surface, round or other shape, without a bottom rim or base.
Potting—Refers to vessels as having been potted, or well potted, that is, well manufactured.
Putois (English: dabbler)—A brush used for tinting or laying on grounding colors in China painting.
Pressing—Modelling ware on a jigger.
Refractory—Not readily yielding to heat; hard to soften or melt.
Rib—An instrument for shaping ware made on a jigger.
Ripening, or tempering, is really a process of fermenting or rotting of the clay or paste, which is exposed to the weather and in many cases permitted to lie for many years.
Rouge flammé—French for a red which is derived from coppèr and has bluish tones.
Sèvres—A famous and high priced porcelain, made at Sèvres, in France.
Silica—Silicic acid. Silica—Quartz, sand, flints. Silicic—Alkali.
Silicate—A salt composed of silicic acid and a base.
Seggars—Boxes of hard pottery, used to place valuable wares in ready for the firing furnace. They are made to stand intense heat.
Slapping—A process for rendering clay homogeneous.
Slip—A thin layer of paste.
Slugs—A piece of sandy clay used in baking stoneware.
Soft—Referring to pottery or porcelain which can easily be scratched with a knife; fusible.
Staniferous—With tin.
Stoneware—Hard pottery, glazed with salt.
Terra cotta—Fired or baked clay.
Throwing—Means fashioning or shaping on the wheel.
Underglaze—Used in regard to painting on pottery before the glaze has been put on.
Unglazed—Bodies or paste without glaze.
Vitrifiable paints—Coloring matter mixed with flux.
Wedging—Treading or kneading the clay.
Wedgwood—A celebrated English porcelain, named after the inventor, Josiah Wedgwood.
Worcester—Celebrated English porcelain, so called Royal Worcester.

HISTORY OF SOME CELEBRATED PORCELAIN.

Meissen or Dresden China.

In 1704 Johann Friedrich Böttger, a chemist by occupation and a genius, gave Elector Augustus the Strong, of Saxony, who was noted for his great extravagance, the impression that he could find the philosopher's stone. He was, therefore, detailed by the Elector and had rooms in the Albrechtsburg, a castle in the little town of Meissen, on the river Elbe, assigned to him as a laboratory, where he was ordered to proceed with his researches. He did not find the sought-for philosopher's stone, but succeeded in producing a red stoneware, which was very hard and capable of standing intense heat. He was kept in close confinement and perfected his invention, assisted by Walter von Tschirnhauszen, until he had succeeded in making fine white porcelain of excellent quality. He continued improving it until his death in 1719. Before his death he had succeeded in finding the kaolin which made his porcelain perfect. His kaolin was found at Aue, in the Erzgebirge (Ore Mountains), of Saxony.

The famous gilding of the early Dresden porcelain, as well as the celebrated Lasur-blue, have been kept secret; and although the inspecting of the factory is free to the public at the present time, it is said that only the head men, or man rather, are familiar with its preparation.

Specimens of Meissen China are preserved in the Japanese palace in Dresden, where they are shown in all stages, from the first teapot of red stoneware made for the Countess Kosel, to the famous bust of a queen, whose head is surmounted by a delicate lace veil made of porcelain fine as a cobweb, which shows the ware in its perfection.

In 1710 the factory proper was established in the Albrechtsburg, but as the beautiful castle was threatened with destruction in consequence of the continual enlarging of the works, it was removed to a new and more commodious building in 1863.

The earlier productions of Meissen were not always marked, but later on every piece was marked, and at the present time no piece is put up for sale without its mark of the two crossed swords. The rule is strictly observed that on any piece that has the slightest flaw the mark is scratched through the center, which testifies to its imperfection and makes it easy for the purchaser to see whether he receives the value of his money, as Meissen porcelain is very expensive.

The first mark used were the interwoven letters, A. R. (Augustus Rex, the Elector, had by this time been made King of Poland and Saxony), reserved only for ware for royal use. Articles for sale were in the beginning marked with a snake twined around a stick, but from 1721 the two crossed swords were the general mark used, sometimes accompanied by a dot or star, according to the period of manufacture. There are also different numbers on each piece, which have a meaning of their own. On undecorated wares the two swords never appear without a scratch in the glaze above them, to prevent such wares which were afterwards decorated by outsiders from being sold as Meissen-painted.

Meissen porcelain is generally painted under glaze.

Among the most popular patterns for general use may be mentioned the "onion pattern," which is a variety of onions executed in conventional style, blue on white ground. Entire sets, from the stately centerpiece and handsome lamp to the tiny pepper box are manufactured with this decoration, and so popular are they, that even the "second choice"—that is, pieces with flaws, sometimes almost invisible—are difficult to obtain; these are sold cheaper, and often have to be spoken for months ahead.

Another favorite design is the "mille fleurs" pattern, which consists of tiny flowers strewed in "all over" design over white ground. These little blossoms are exquisitely done, and articles thus decorated have a most dainty look.

These are only a few of the many decorations used; a more elaborate description is excluded for want of space.

It may be mentioned that Meissen, at the present time, produces very fine porcelain, which, not belonging to the royal factory, has, of course, not its mark, but is stamped with the word "Meissen." The large, handsome Meissen parlor stoves, made of fine tiles, have also added to the world renown of this little town.

The cradle of Meissen porcelain, the Albrechtsburg, has since been renovated and restored to its former beauty, and is now one of the residences of Saxony's king.

In spite of the great precautions used, which pledged the workmen to secrecy and silence, a great deal of spurious ware was thrown upon the market. Not many years ago a number of workmen were discovered wh

had workrooms and kilns under ground, where they manufactured goods at night, and had succeeded in selling a great deal before their exposure.

One of the workmen, employed in the early times of the manufactory of porcelain, escaped in 1720 and made his way to Vienna, where, in due time, fine porcelain was made. It gained its greatest height there during the reign of Maria Theresa. The Austrian Government suspended the manufacture in 1864.

At the present time large factories exist in Bohemia. Next to Meissen porcelain in Germany comes that of Berlin. It was made first in that city in 1751, but was not of best quality until Frederick the Great removed some of the Meissen workmen to Berlin. He also had the kaolinic clay from Aue, which Meissen so far had monopolized, brought to his factories, and very fine porcelain was made and is being made there at the present time.

There are a great many more porcelains of German manufacture, but the most renowned are the aforementioned.

England has produced porcelain of high quality, although for a long time it had no particular distinction from that made in other places. This was a soft ware. About the year 1800 Josiah Spode succeeded in bringing a new kind to perfection—*bone phosphate porcelain.* This is the ware now manufacted in England. *Bone* is a prominent factor in the manufacture of English porcelain. The phosphoric acid of bone diffuses into the materials, and forms them into a translucent enamel, which does not lose its form or sink as easily as hard porcelain. Therefore large kilnsful can be baked without much risk to the manufacturer.

America and Ireland furnish most of the beef bones, those of other animals, such as pigs or horses, imparting an undesired color to the paste.

No definite dates can be given as to the infancy of English porcelain; the beginning of its manufacture is located about 1740 to 1743.

In 1745 the factories of porcelain in Chelsea were in good working order, and important results were achieved. Chelsea has a tint of its own—a beautiful deep claret red. Another popular tint was *bleu du roi*, used as a flat tint, surrounding painted medallions or panels on white ground. Gilding was also applied elaborately in different styles.

Among other English porcelains of the eighteenth century rank *Bow* porcelain, which was made at Bow from a clay imported from America, and was rather hard. Derby porcelain was made as early as 1750. It is elaborate, somewhat in the Meissen style; the underglaze blue ware particularly fine. Different marks were used; for example, *D* with an *anchor*, and *D* surmounted by a *crown*.

The year 1751 brings the Worcester porcelain made by Dr. Wall, a physician and chemist. The early wares were very artistic, chiefly copies of the Nanking and Japanese styles. George III gave the factory the title "The Royal Porcelain Works." Among the different marks used a "W" is the earliest, also a crescent. The modern wares of Worcester are very beautiful and delicate, the "*pâte sur pâte*" (paste on paste) being very skillfully applied. Its name at the present time is "Royal Worcester," and it is just now very popular. Among other famous English wares are the *Minton*, *Doulton*, and *Wedgewood.* Doulton porcelain is made at Lambeth; it is very beautiful, and brilliantly yet daintily decorated. Minton and Wedgewood are also beautiful styles and would require a most extensive description, being much varied in style and decoration, some being most exquisite.

The manufacture of French porcelain dates back to about 1664; it was soft ware.

The most famous and costly French porcelain is Sèvres, called so after the place where it is made. Up to 1770 this was soft; after that period hard Sèvres was manufactured. The earlier wares were made at Rouen and St. Cloud. The St. Cloud was in imitation of Chinese goods. Two workmen, brothers Dubois, escaped from the factory in St. Cloud to Chantilly; afterwards they went to Vincennes and proceeded to make porcelain. Not being successful, it devolved upon the Marquise de Pompadour to bring the manufacture of French porcelain to a point of success. Modeled flowers of great beauty were produced at Vincennes, which cost enormous sums. Remnants of these wonderfully formed flowers are preserved at the Musée Céramique.

Great rivalry sprung up between the factories of Meissen and Vincennes. In the latter place the workmen were kept as jealously confined as their fellow-workers of Meissen.

The year 1754 saw the porcelain in its perfection, and the buildings at Vincennes being found insufficient, a large edifice was erected at Sèvres, whence the factory was removed in 1756. In 1760 Louis XV bought the establishment, and retained M. Boileau as Director. The King and Madame de Pompadour took the greatest personal interest in it, and visited it once a week. The artists and other employés were kept in superior style, and all opportunities for amusement were afforded them, under which happy circumstances large amounts of superb ware were produced, and the sales of Sèvres grew to such magnitude that it was difficult to fill all the orders. As yet, though, nothing but "pâte tendre" (soft paste) had been made, although hard paste had been made for many years in Meissen.

The great obstacle to the making of hard porcelain was the lack of kaolin, as the latter substance within reach resulted in coloring the paste gray. By chance a lady, Madame Darnet, happened to discover kaolin at St. Yrieix, near Limoges, where it is found in quarries in great abundance and superior quality, accompanied by the indispensable perfectly white feldspar.

In 1769 hard porcelain was produced at Sèvres, but was not equal to the creamy softness of coloring and artistic beauty of painting of the soft paste ware, nor did it have the deep glaze. Both kinds, however, were manufactured until 1804.

Napoleon I also took great interest in Sèvres ware, and frequently made presents of specimens.

M. Brongniart, an eminent geologist and chemist, was for nearly fifty years Director of the works. He was also the author of "Traité des Arts Céramiques." He remained Director up to his death in 1847.

A beautiful rose tint, called "rose Dubarry," is peculiar to Sèvres, also "bleu de roi" and "bleu turquoise." Sèvres is sold for fabulous prices.

The marks are numerous, commencing with the Royal L in blue. The artists mostly added their monogram. Tables have been made of the marks according to the period of manufacture, too lengthy, however, for this article.

The Limoges ware is made at Limoges, in France, and is very famous. The ware is lead-glazed earthenware of more or less hard body, and the decoration peculiar to it is called *slip painting*. The coloring matter is mixed with thin paste and used with bristle brushes, which enables the artists to apply the paints like oil colors, in this manner giving body to the decoration, while the transparent lead-glaze, often united with borax, adds great depth and beauty to the colors. Borax improves the colors much, particularly the blues. The method of slip painting has been improved upon at Limoges, it having been a style of decoration used in the earliest times. The slip is a strip of paste, which must be of exactly

LAMP. AMERICAN ART FAYENCE. GREENPOINT, NEW YORK.
Height, 57 inches; circumference, 35 inches.

[illegible] PITCHER [illegible]

the same composition as the article which it is to be used on. The same condition refers to the paints, which must in composition correspond with the slip, to prevent any cracking. An alkaline glaze is put over the whole. This transparent glaze lends great beauty to the colors. There are differences in the slip and glazes used in different factories, and great secrecy is practiced regarding them. The works at Limoges are very extensive, over five thousand artists and workmen being employed.

The kaolin which is found at St. Yrieix, is very superior and is exported even to America. The pegmatite used is also found near by at Chanteloube.

Belleek, Ireland, produces a very fine porcelain, belonging to the eggshell, which is much decorated in relief.

Very exquisite work of extreme delicacy is made at Geneva, Switzerland, and called Geneva ware. Its decoration is in the style of the Limoges, and has a deep glaze over rich, soft coloring. The *Geneva* ware is ornamented with slip painting and modeled flowers, while the *Swiss* ware has a style of decoration of its own, which looks like enameled jewelry or mosaics, slightly raised and covered with a deep glaze.

MANUFACTURE.

In America hard porcelain is manufactured, and, as will be seen in the article on clays, all the materials necessary are found in this country. About 1825 Wm. Ellis Tucker commenced making it in Philadelphia. At the present time factories are producing hard porcelain in various parts of the United States—at Trenton, New Jersey; Green Point, New York. There is no reason why, with the abundant materials available in America, pottery and porcelain should not have a great future before them. As seen in the article referred to before, California is rich in large deposits of all kinds of materials required for making numerous different wares of all grades.

Very beautiful ware, called American Belleek, is made at Trenton, New Jersey. It is a close imitation of the famous porcelain made in Belleek, Ireland. In fact, the reproduction of it is so fine that it surpasses and has taken the place of the original ware. The workmen of Irish factories, Ireland, have been brought over to Trenton, and articles of unsurpassed beauty are now made there. This porcelain belongs to the eggshell class, the principal decoration being in relief. The shapes are quaint, lotus flowers and water lilies being a favorite design, their broad leaves, deftly modeled and curved, standing out boldly, while the stems are gracefully twined to form handles. This ware has a beautiful iridescent luster, resembling the inside of a pearl shell. The coloring is rather subdued, yet rich, and gold, burnished, and matt is much used.

A special mention should be made of the wares made at Cincinnati. Miss Louise McLaughlin, the author of a practical manual on china painting, has, after numerous experiments, conducted with greatest patience and perseverance, succeeded in making a ware which closely resembles the famous Limoges. After many unsuccessful attempts, made in various parts of Europe, to imitate Limoges Faïence, it has devolved upon an American woman to solve the difficult problem. Thanks to the persistent application to her task, she overcame all difficulties, and has produced articles of wonderful beauty. This ware is decorated in the Limoges slip-painted style, with bold effect, warm coloring of great strength, and much artistic feeling. These articles have a harder body and glaze than the original Limoges. One of her large vases, exhibited in this State, was decorated in bas relief: a large, red fish, caught in a net. The whole piece was executed *boldly*, showing great breadth.

WORK OF LOUISE M. MCLAUGHLIN.

In 1878 specimens of this work were sent to the Paris Exposition. About the same time Miss McLaughlin achieved her first success in painting blue underglaze on white ware.* She has since published another book, "Pottery Decoration Under the Glaze." The lady has steadily continued her researches, and many works of art and great beauty owe their existence to the intelligent and deft fingers of this pioneer of American decorative pottery, destined to associate her name forever with this industry.

(The first notable exhibition of Cincinnati decorated pottery was held in May, 1875, at the old Elm Street Exposition Building. This has been followed by larger exhibitions.)

In making pottery naturally the principal ingredient is the clay, which is used in its natural state for the coarsest ware, and is called body or paste (French: pâte). The primitive way of utilizing it is shown in the sun-dried vessels, tiles, or adobe bricks made in ancient times in Egypt and Assyria, and even now in Mexico and other tropical countries. These sun-dried articles can only be used in a dry state. The baking or firing only renders them insoluble for liquids. The degree of temperature which the ware has to be exposed to in the baking depends on the composition of the paste, for which clay serves as a base.

C. A. Janvier has arranged tables which show the composition and proportions of different wares, and it might be appropriate to insert a copy of these tables in this article. (See pages 258–261.)

The wares to be produced depend upon the composition of the ingredients, the clay which they are mixed with, and the temperature which they are baked in. Paste may be called modified silica. If the paste or body contains but very little iron, lime, etc., it will bear a high temperature, yet not melt. Much iron, lime, and other impurities flux the body at a low heat, so that it will melt into a shapeless mass. The alkalies which the clay mass generally contains, such as feldspar powder and dust, do not influence it at a low degree of heat, but they will, aided by lime, act as very strong fluxes, if the heat is sufficient to melt the feldspar.

The plasticity of the clay is of great importance, as the modeling of the ware depends upon this quality.

Plastic clays are called fat or long; the less plastic, short. If the clay is

* In 1879-1880 she produced her "Ali Baba" vase, said to be the largest piece potted in the United States. She presented this vase to the Women's Art Museum Association of Cincinnati. Other ladies and some gentlemen have followed Miss McLaughlin's example, and wares of great merit are being brought forth.

too plastic, the ware will shrink too much in the baking and lose its shape, therefore ingredients are introduced which are non-plastic and unshrinkable. Potters call these "pitchers" (French: ciment); they may be sand, calcined bones, chalk, baked clay, or porcelain pulverized, calcined flints, even sawdust, which latter, however, burns out and leaves spaces in the clay. For objects of more or less elaborate form, most careful calculations have to be made to allow for shrinkage; for simple pieces, such as plates, this is not of much importance.

After the clay which is to be used for very fine wares has been dug up, it is dried, and after having been broken up all foreign bodies are carefully removed. It is then put into a "blunger." Very pure water is added and the mixture worked with paddles attached to a shaft, until it has the consistency of cream. After water and clay are thoroughly mixed it becomes "slip" and is now drawn off and run through a series of strainers or sieves, which gradully become finer meshed until it finally passes through one of exceeding fineness. Another process consists of washing the mixture down through a succession of tanks, in which the heavier parts sink to the bottom.

Whatever "pitchers" are to be added must be pulverized as finely as possible. In China and Japan this is done very primitively, in Europe and America by excellent machinery. (In this country, Alsign's dry grinding cylinder mill.) The potter tests the pulverized material with his teeth or rubs it between his fingers.

The clays and pitchers thus prepared can now be mixed either in a powdered state, or, which is more usual, each ingredient has a certain proportion of water added, so that a quart of one will be equal to a quart of the other. After this they are generally mixed in a machine similar to the one before mentioned. Water is added until the liquid is like cream and can pass through the finest gauze. The slip is now dried, as it must not be left in a liquid state, in which the heavier parts would sink to the bottom; in this state, also, the slip would not be plastic. Various methods of drying the slip are employed: exposure by air, or by absorbing it in plaster boxes, etc. An English firm invented an ingenious method of *straining bags*, which are used in larger potteries of Europe and America.

The paste now has to be rendered as homogeneous as possible in texture, and all air bubbles must be removed.

One method of doing this is very old: kneading it with hands or feet, called "treading." After placing the tray on a tiled floor, the workman walks with bare feet from the outer line to the center, spirally, until the clay is sufficiently "treaded." Another process is putting the paste into a mill, called a "wedging mill," which consists of a cylinder having knife blades inserted in the sides and in an axis in the middle, arranged in such a manner as to cut the clay and force it into a spiral. This process, after having been repeated several times, is considered more effective than the "treading." Yet even this is not sufficient for very fine wares, such as porcelain. For this ware, the clay, just before using, is treated to "slapping." A very strong man raises a quantity of about fifty pounds and cuts it through with a brass wire. He then throws the cut-off piece with all his strength on the other part, and repeats this until the paste is perfectly smooth and close where it is cut. After this it is pounded with a mallet. If this has been thoroughly done, the blending must be so thorough that any coloring matter added to it will be equally mingled through the whole. By this operation the air is also driven out, which is most important, as air bubbles expand in the baking and ruin the ware. The process of wedging has almost entirely superseded that of slapping, but for the very finest wares nothing seems to answer as well as the hand work.

Frequently the clays and pastes are allowed to "ripen," that is, they are left in the open air exposed to the weather, or put in pits or cellars to temper, and kept moist. Sometimes even putrid water is added to assist the mass to ferment and putrefy. The ripening is often extended to many years, particularly in China.

The coarser wares do not undergo all these processes, treading or wedging alone being considered sufficient. The finest ware receives the most elaborate treatment.

The paste being sufficiently prepared, it is ready for shaping or modeling. The most primitive way is shaping it with the hands. This is yet done in Spain, where huge jars are thus made. The famous Japanese Banko ware is also pinched and patted into pretty shapes.

The ordinary way, however, is making pottery on the "potter's wheel," which was employed for this purpose at least four thousand years ago. The potter's wheel varies in form according to the power used for moving it.

Differently formed articles require different processes of shaping, such as *throwing*, *pressing*, and *casting*.

Throwing is employed for hollow vessels. A piece of clay or paste is placed on the small platform of the wheel, which rapidly revolves. The potter then shapes this into the object desired, using his fingers and a wet sponge, maybe also some simple modeling tools. He first forms a cone, which he forces again into a heap. He then thrusts his thumbs in and hollows it out, running it up into a sort of hollow cone; then finishes it off properly with hands, sponge, and tools. This seems all very simple, yet is very difficult. Good throwers are trained from boyhood up. When the piece is finished he cuts it away from the top of the wheel by slipping a brass wire under it.

Fine wares are often finished off on the outside by another man, who uses for this purpose a *lathe*, called potter's lathe. It is similar to the ordinary turning lathe.

Flat pieces, plates, etc., are made by *pressing*. The *presser* takes a piece of paste, expels the air by beating and slapping, and rolls or beats it into a thin layer. Sometimes a sort of rolling-pin is used, the presser placing the layer of paste *outside* the mold. Fine wares have to be handled with great care in lifting the paste; generally it is rolled out in soft leather. Now the paste on the mold is placed on the head of the wheel, here called *jigger*, consisting of a spindle resting on its point, which is provided with a head to place the mold on. The wheel may be turned by a treadle used by the workmen, or by machinery. The jigger is moved by the same means, sometimes a boy turning it. The process of pressing is repeated several times—no less than twice. After drying them enough to have the proper consistency, the plates, etc., are taken off, smoothed inside, and finished off as finely as desired.

Large pieces, and also small ones, are now mostly made in molds of plaster of Paris, which gives the shape, and sometimes ornaments, to the outside half of the piece. To make a pitcher, for example, the potter spreads a thin layer of paste inside the hollow mold and presses it carefully into it with a wet sponge, taking care to keep it even in thickness. The same is done to the other half. Then the two halves and the bottom piece are fastened strongly together, the place where they are joined wetted with slip and smoothed down. Plaster molds rapidly absolve the surplus moisture, when the paste will be found dry enough to permit the pitcher to be lifted out and put away to dry. In spite of the greatest care taken in joining the two halves, the line where they meet will show after baking, so that in fine wares it is of great importance where this line is to be. This mark is turned off by a lathe.

The plaster molds are of rather recent date, and particularly suited for the purpose, as they absorb the water so rapidly. They have, therefore, almost entirely taken the place of baked clay or metal molds.

Some ornaments, handles, and spouts are molded separately and fastened to the vessel with slip. Ornamented handles are pressed in molds, and must be carefully handled, not to become bent or distorted. For plain round or flat handles the paste is forced in long strips through holes of the desired shape, and cut up to suit, after which they are fastened with slip.

Very thin ware is made in a sort of double molds, the inner of which may be in one, two, or even more pieces, carefully fitted together, and held in place by the outer mold. Into this mold very thin slip-paste is poured; this soon adheres to the absorbent plaster and thickens rapidly. When it is considered of the proper thickness, the superfluous slip is poured out. After the paste has dried and contracted, the mold is carefully taken off. To compress the thin layer of paste and give it sufficient consistency compressed air is frequently forced into the molds. This process prevents very thin vessels from falling to pieces.

Pieces which require great neatness and delicacy are best executed by this method; very thin cups are made by it in molds and the feet put on afterwards. Handles also are sometimes hollow and made this way by slip, to be used for eggshell porcelain.

For basket or openwork ware the spaces are cut out of the solidly molded article very skillfully by hand, by the workmen, or rather by clever workwomen. A very delicate process is the making of vessels double, with the outer part cut into openwork designs. In this case the inner part is made first, then the outer part or shell placed on it, and joined by slip at points of contact. Care must be taken to have both pastes of equal consistency, so they will contract equally. The desired pattern is then cut into the outer shell, refraining carefully from letting the knife touch the inner part.

Lacework is in most cases made by dipping the lace, of the desired shape and pattern, into slip, after which it is draped upon the article before baking. The lace proper burns away in the baking, and, on account of shrinkage, leaves the slip-lacework on the article more delicate of fiber than the original lace. The workwomen who mostly perform these delicate tasks, also ornament pieces by *dragging* or *dropping* the paste, mixed to the proper consistency, over the vessel, as the confectioner ornaments cakes.

Large potteries employ their own moldmakers; for fine ware, good artists, and often famous sculptors.

The celebrated eggshell porcelain is made by enameling the pieces on the inside, and after baking them, removing the paste by grinding, leaving only the enamel. Then another coat of thin enamel is placed on the outside.

Bricks, tiles, drain-pipes, and ornaments for architectural purposes are generally molded or cast by machinery.

Many more processes could be added and more minutely described, as they vary in different countries according to wares and machinery employed. Many machines for perfecting the manufacture of pottery are used in Europe and America. The easiest way and the most instructive is to watch the various processes of potting in a pottery; this is as practicable as interesting, and teaches more than the most elaborate description.

After the potter's task is finished, the moist pieces are taken to be dried. They are placed on plaster shelves in the drying stove or closet, and exposed to a temperature of about 125 degrees Fahrenheit, beginning with 90 degrees, until they become hard enough to be handled. They are then baked. The ware may be baked unglazed (biscuit), or it may be baked slightly *and then glazed;* or it can be glazed and baked at one time.

Glazing means to cover the articles with a thin coat of natural or artificial glass. The composition of glazes must vary in fusibility, according to the ware which it is to cover. To prevent the cracking (technical expression, "crazing") of the glazes, they must expand or contract in proportion with the ware.*

It is generally easier to glaze very siliceous wares than those containing a large proportion of alumina. The materials for composing glazes most used are feldspar, kaolin, quartz, sand, lime, borax, boracic acid, sea salt, potash and soda, fluorspar, ochers, oxides of lead, of manganese, cobalt of iron, and oxide of tin. The best glazes have borax and some alkali added as a flux; in this case the proportion of lead is reduced. Glazes which contain much lead are easily scratched and decomposed by acids; they are therefore dangerous if used for cooking utensils. Without entering more minutely into the composition of various glazes, which, in numerous cases, are secrets of the manufacturers using them, a general description of the process of applying them may be made. The ingredients for ordinary glazes are ground to a fine powder (the finer this is the more lustrous the glaze); water is added to the consistency of cream. This composition, with the addition of a little vinegar to prevent a precipitation of the heavier parts, is applied without any more preparation.

Another process is *fritting*. This is a melting of different ingredients with any salt soluble in water, as borax, niter, or soda, into glass, running this into cold water and then breaking it up into fragments. This "fritt" is then pulverized, and insoluble materials added, if necessary. The ware is then dipped into this glaze liquid. After the water is absorbed by the porous ware, a thin coating of powder is left, as if the piece were powdered with sugar. Any bare spots are covered with a brush, and where the pieces came in contact with the "seggars" the glaze is wiped off. In non-porous wares other processes are employed.

The glaze is made into a thick liquid, and some of it put on, or, as needed, inside the vessel, which is moved around until the glaze covers it evenly. The glaze may also be applied with a brush, etc. In England some glazes are "dusted" on. The now glazed ware, if entirely dry, is placed in the kiln ready for *baking* or *firing*.

The proper placing or packing of the wares in the kiln is most essential, and a branch of the manufacture in itself. It requires a skillful and experienced workman, who has a task of great responsibility.

The *kilns* vary in form; some are cone-shaped, others square with arched tops, or circular buildings; some are two stories high. The most essential quality is an equally distributed heat.

Within the later years numerous improvements have been made. Instruments for measuring heat, called *pyrometers*, are used. Skillful potters, however, judge the heat by experience. They can gauge it to great exactness by placing pieces of paste within easy reach in the kiln and examining them during the process of baking. Small apertures are left in the kiln for looking into it. These are carefully closed, though, when not used.

Formerly wood was the fuel always employed for heating the kiln, now, however, charcoal, coal, coke, and even gas with regenerative stoves are employed. China and Japan use wood only.

The coarser wares are simply placed in the kilns with the fire playing directly on them. The finer wares are placed in "seggars," which are dusted with fine flint sand to prevent the pieces from adhering. The seg-

*One of the oldest, and said to be lost arts of the Chinese, is the crackle ware. This effect is produced by an artificial expansion of the glaze. Several methods of making *this crackle* ware have been published, but there is no certainty as to their being the *genuine Chinese*.

LARGEST VASE POTTED. AUSTRIA.
Height, 92 inches; circumference, 88 inches

gars must be packed with great care, little props or pins, stilts, etc., of fire-clay being used to keep the articles from touching. Numerous other methods of packing kilns are in use, according to the consistency of the wares, the *soft* paste needing greatest precaution.

DECORATION.

The only method of decoration really correct and adapted to pottery or porcelain is that which is indestructible. This law, in regard to colors, demands their being derived from minerals, as any animal or vegetable matters will not bear a temperature high enough to fire pottery or porcelain. Therefore, the pigments used are necessarily *oxides* and *salts* of *metals*. Of these, not all are capable of standing the high temperature of the glazing kiln. It is, therefore, necessary to confine certain colors to overglaze decoration, as the temperature needed to fix the colors on the glazed surface is not so high as that which is required to fire the glaze. In *overglaze* painting, the pigments unite with the glaze during the process of firing, and make them as one. In *underglaze* decoration, the painting is applied to the *unglazed* ware, and the glaze put over the decoration. The ware being so far only biscuit, a mellow softness of the tints is the result, which makes the Limoges ware and that of Cincinnati so beautiful. The ground tints are blown on with an atomizer, invented for the purpose, which results in the marvelously soft, cloud-like backgrounds, which have made this ware so famous. The high glaze, which is added afterwards, only tends to subdue the tints more, without lessening their strength in the least. Great care is taken to employ only tints which harmonize, and the results are due to the truly artistic feeling of the decorators, who are real artists.

To more easily understand the different styles and methods of decoration, it must be explained that the fixed colors should be classed as *enamels* and *vitrifiable paints*.

The difference between enamel and vitrifiable colors is, that the color is not mixed with the glass, but *dissolved* in it. To use chemical expressions, enamels are silicates, borosilicates, or phosphosilicates, colored by oxides in solution. The colored glazes and most of the underglaze colors are enamels. These latter must either be prepared with the coloring matter and placed on the ware, or the materials for the enamels placed on it, and the two united in melting. In using enamels for overglaze painting, certain conditions must be observed, or they will crack and come off. Enamels can be more or less *transparent*, or they may be made quite *opaque* by adding very carefully prepared phosphate of lime, or oxides of tin or of antimony.

Paints are *vitrifiable* when the coloring matter is mixed with the flux, instead of being dissolved in it, as is the case with the enamels. Most of the colors used for overglaze painting on hard porcelain belong to this class. These colors must possess certain qualities, which are: 1. They must not chemically change in melting at a certain temperature; 2. They must firmly adhere to the article applied to; 3. They must come out of the fire glossy (this is not applicable to the "matt" or unglazed colors); 4. They must not be affected by moisture or dry atmosphere, or by gases; 5. They must expand or contract in proportion with the surface applied to. Where it is possible the colors should remain the same after firing as before, and not destroy each other when mixed. This should be the case with enamels also. As the surface on which fluxed paints are used is generally less fusible than the paints, it happens, especially with hard porcelain, that the glaze remains *hard*, while the paint melts at a low temperature, which

causes it to form hard outlines, and even to crack or scale off. A softer or more fusible glaze, for example that of soft porcelain or faïence, will permit the paint to sink into it slightly, thus giving a very rich effect to the work, and uniting pigments and glaze so thoroughly that there is no danger of scaling. This rich, soft effect is also achieved by the mingling of color and glaze in majolica. As in the mixture of clays and glazes, the recipes for composition of fluxes and paints vary, and each manufacturer has his own special compounds. Speaking of fluxes or colors in a general way, it may be stated that flux and coloring oxides are carefully ground to an impalpable powder, this being of greatest importance to the brilliancy of color and the gloss of surface. On the average, about three parts of flux are mixed with two of coloring matter, varying, however, in proportion, according to shades desired, and also to the ware on which they are to be used. Cobalt blues and copper greens have to be subjected to a greater heat in order to bring out the full strength of the color; these are, therefore, melted with the flux first, then cooled and finely pulverized. Fluxed paints are usually put in the market in fine powder. When used they are mixed with turpentine and *fat oil*, which latter is the sticky substance gained by exposure to air of spirits of turpentine. The constant researches of chemists have resulted in bringing forth numerous new colors of greatest beauty. There are three general classes of pottery paints: *Underglaze*, or refractory, also called *gloss-oven* colors; *hard kiln*, or medium heat; and *regular kiln*, or ordinary or soft muffle heat. Underglaze colors must be prepared with regard to the pottery which they are to be used on, so no injury will be done to them by the material used for paste or glaze. The *engobe* or *slip* painting referred to before is done with underglaze or gloss-oven paints.

The colors for hard potteries have to stand such a high temperature that they are not so numerous as those used for soft ware. As the temperature becomes lower, according to the different wares, the range of colors becomes larger. After underglaze colors have been applied, the ware is subjected to a process of *hardening*, a sort of preliminary baking, which requires a red heat. The glaze is then put over it. The colors may be called *potter's* hard colors. *Decorators* generally refer to *hard kiln* or medium heat—sometimes high muffle colors—in speaking of hard fire colors. These vary little from the regular kiln colors, and are, like them, applied *over* the fired glaze, never under it.

The third class colors—*regular* or *ordinary* kiln colors, also soft muffle colors—come in tubes or in powder, for use over the glaze on porcelain, and are called porcelain paints, mineral paints, etc. Lacroix, who manufactures them so extensively, calls them "couleurs vitrifiables."

The Chinese and Japanese have rather limited lists of colors, as their knowledge of chemistry is not sufficient to produce new ones. Some of their colors, however, are famous; for example, *céladon* and *rouge flammé*, or flambé.

PAINTING.

Probably no style of painting is more popular with the amateur than porcelain painting. Why this should be seems difficult to explain, as it is decidedly not "easy," nor by any means a thankful task unless done well. Yet it appears as though no branch of art were more sinned against than porcelain painting. The only explanation may be that the average amateur desires *result*, without being compelled to undergo the tedious preliminary studies so patiently followed by the professional. It is well known that porcelain painting by many artists is looked upon as merely a *technical* industry, not an art. By the writer of this article, however, good, *artistic* work on porcelain is considered very difficult, as bad or indifferent

work is brought out more prominently by the firing, which softens no blemish and hides no mistake. One of the greatest difficulties in porcelain painting, and particularly in overglaze work, is that the surface is not yielding, like paper or other materials used for painting. Great skill in wielding the brush is therefore required to bring forth the softness of outline so much desired in all painting. The widely cherished idea that a knowledge of drawing is not necessary for porcelain painting, and that tracing is not only perfectly legitimate, but a rather capital substitute for drawing, may have something to do with the popularity of this decoration, which is more resorted to as a pastime rather than a true study.

The first and foremost condition necessary to success in any branch of art, a knowledge of drawing, is also an absolute necessity in pottery and porcelain painting. Of course, if the student's ambition is satisfied with very moderate success, simple decorations are often executed with good effect; but where really good work is desired, the student should not expect to accomplish anything without a proper foundation, artistic training, and unceasing perseverance.

Numerous lists or "palettes" for this work are made out, according to the preference which teachers and professional decorators have for certain colors. The latter generally use those which come in powder, and prepare them according to their liking. The tube colors are ready for use and need only be rubbed with a little turpentine to make them pliable. Lacroix's tube colors are probably more used than any others. These tubes contain colors ready for painting and also for "tinting" or "grounding." These latter are prepared for grounding only and will not bear mixing with others, as they contain too much flux. English colors are also much used by artists, as well as German. Many prefer to select their palettes from different makes, choosing particular colors which they consider best, regardless of the maker. Thus, English and German decorators will use Lacroix's Rose Pompadour largely.

Ulrich's enamel paint in tubes (German: schmelzfarben) and powder, are also much used, being rich in colors and coming from the firing with a high glaze. The so called *Matt wax colors* are adapted for painting in Royal Worcester style and have a beautiful, soft effect. Another new kind are the "new Gouach colors;" also particularly adapted for Royal Worcester style of painting.

The so called Royal Dresden china colors come in tubes and porcelain pans, put up like moist water colors. They are handled like water colors on glazed porcelain, which has previously been covered with a medium specially intended for the purpose. Porcelain which has been decorated with these colors is fired just as if vitrifiable colors had been used; the porcelain water colors are exceedingly rich in tone, but difficult to manage.

A special point has always been made of cautioning against the use of different colors, that is, those of different make, on the same work, as it was contended that the use of different colors side by side would result in uneven firing. Many professionals, however, claim to have achieved great success by using colors of different manufacture at their own pleasure, some even employing Lacroix paints in touching up work executed in Hancock's moist water colors. For beginners, though, it would be advisable to confine themselves to one set of colors.

Manuals for china painting give different lists of colors or "palettes," according to the preference of the authors; it is advisable, however, to observe the same rule which applies to all styles of painting; that is, the student should confine himself to as simple a "palette" as possible, as this will make the work easier and less puzzling. As porcelain paints change more or less during the process of firing, the painting must be done with

the desired result in view. A certain familiarity with the colors *before* and *after* firing is therefore desirable, which can be accomplished by making sample "palettes." For this purpose a large, rather flat plate is to be divided into as many compartments as colors are to be used. Now, a little paint is to be squeezed on the "ground" surface of a glass slab and "rubbed down" with a palette knife, using a horn or ivory spatula for colors containing gold, little or no iron. Enough turpentine must be added to make it easily managed, then the compartments filled in by putting the color on thick on the outer edge, and letting it become lighter gradually, until it blends into the white porcelain. Each color must be numbered with ivory black, and a corresponding list be kept to refer to. Those who do not wish the trouble of painting a sample plate, can buy them all ready at the art dealers, as the manufacturers of colors make these plates containing all colors, both for painting and "grounding."

Complete "outfits" can be had at any art store, including the different mediums needed for the work, as turpentine, fat-oil, oil of lavender and cloves, balsam of copaiva, etc.

The actual process of painting may be described as follows: After the article to be decorated has been well cleaned, prepare it for receiving the design. This should be sketched "free hand" with a finely pointed lithographer's pencil, or a hard lead pencil. The porcelain surface will receive the latter better after having been rubbed over with a little turpentine or alcohol, the former being preferable. As soon as the surface is dry, the design can be sketched on, as lightly as possible, so the pencil lines will not soil the paint. If tracing paper has to be used, great care must be taken to use an instrument which will make the lines as delicate as possible. Tracing in itself must be done very cautiously, otherwise the design may lose much of its character.

If a "tinted" ground is desired the prepared color is laid on in a flat tint with a broad, flat brush or *putois*. After the surface has been evenly covered and allowed to remain until it has become somewhat "sticky," it is gone over with the "blender," which is held perpendicularly, "dabbing" the article lightly until an even tint is attained. Instead of the blender, a ball of cotton tied in chamois skin, linen, or raw silk can be used.

In factories and by professionals another method for laying grounds is largely practiced. The porcelain is evenly and quickly covered with "grounding oil" especially prepared for the purpose. This done, the surface is lightly dabbed with a ball of cotton tied in raw silk. When slightly "sticky" the powdered color is "dusted" on with a large brush, any superfluous powder being lightly brushed off. This method requires skillful handling.

Designs or patterns are sketched on tinted grounds as described before, and the color removed by "scraping" it off or applying mediums mixed for this purpose, for example, lampblack, balsam of copaiva, and oil of cloves. This medium is applied with a brush, and after remaining a little while on the surface it is quickly wiped off, exposing the white surface. After the color has been removed where the design is wanted, the ware may be fired, or the design painted on at once. Referring for a detailed description to works which are especially published with the view of giving instructions, it may be added that a practical course in porcelain painting is the only method of learning to conquer the many technical difficulties which accompany this particular branch of art.

After the painting is finished the article must be kept free from dust until dry, when it is ready for firing. Gilding, putting on bands or lines are special branches, and should be left for the professional decorator. *Burnish gold* (German: polir gold) comes dull from the kiln and is pol-

ished with burnishers. This work is generally done by women, and requires practice. Another style of gilding is done with "glanz gold," which comes bright from the kiln and needs no burnishing. This is used for cheap ware and not so lasting as burnish gold. Very effective styles of decoration are achieved by leaving the gold partly dull and partly polished.

For putting on bands or lines "whirling tables" are used. The decorator, after placing the article directly on the center of the whirling table, steadies his arm on the "rest," and, applying the brush charged with paint to the object, moves the wheel rapidly with the other hand. This requires skill and practice.

In factories fine ware generally receives several firings. Meissen or Royal Dresden articles are fired as often as six times or more. Generally speaking, all painted articles should be fired twice at least. For the first fire the work should be done in a sketchy manner, leaving the details to be worked up for the second, or, if desired, third firing. Beginners should practice considerably before having any of their work fired at all, wiping it off repeatedly, until the teacher considers it done well enough to be preserved by firing it.

FIRING.

The packing of the kiln for firing painted ware is as responsible a task as the packing of one for "green" ware, and must be done by an experienced person, as some of the colors require more heat than others. Particular care must be paid to carmine. Very fine ware is generally placed in "muffles," which are similar to the before mentioned "seggars." To prevent articles from touching, which would result in their adhering to each other on account of the glaze melting them together, little stilts or triangles of "biscuit" are used. After the kiln has been carefully packed and the proper heat attained, the process of firing can be watched through the "spy-hole." It is quite interesting to note the gradual heating of the ware: the painting turns darker as the temperature increases, becoming a reddish brown; then, as red heat is attained, a bright red, and lo! disappearing entirely as soon as white heat is reached; then gradually appearing again, turning red, reddish brown, and so on, until the different colors have returned, only brighter, and covered with transparent glaze. The fire is lowered gradually, and the kiln must be permitted to become quite cold before removing the articles.

The time necessary for firing is about three to five hours for fusible colors, underglaze colors and glazing about thirty-six. This is only taking a general average. Gold requires a higher temperature than that at which silver melts. By means of trial pieces the different degrees of heat required can easily be observed. Carmine, if not subjected to enough heat, will burn an ugly brownish hue; if overheated, an equally ugly violet.

Amateurs employ largely the portable kilns, and achieve, with great care, comparative success. In many cases gas is used, and the firing done in quite a short time. These kilns are not suited, however, to large pieces.

Referring again to an article in another part of this report, which contains the results of chemical analysis of clays and kaolins found in California adapted for the manufacture of pottery and porcelain, it is sincerely to be hoped that the facilities which this State offers, namely, large deposits of all necessary materials, will, in the near future, lead to their development, and thus lay the foundation to a new industry, which, hand in hand with art, will add to the fame of our State.

TABLES OF PASTES.

KINDS OF POTTERY.	Silica	Alumina	Magnesia	Potash and Soda (not separated)		Iron	Lime
Soft Body or Paste.							
1. Peruvian	67.04	10.83	0.28	......	......	10.17	3.24
2. Madagascan	44.00	31.20	......	......	......	7.05	1.25
3. Campanian (Italo-Greek)	52.95	27.15	1.76	*	*	12.87	5.25
4. Etruscan	63.00	14.44	......	......	......	7.75	3.00
5. Roman (red) Luxembourg	54.39	24.24	1.83	......	......	10.24	9.25
6. Roman (gray)	61.58	25.78	3.05	......	......	4.27	2.17
7. Black, Gallic	62.22	18.36	0.47	......	......	5.71	1.17
8. Spain, modern	53.04	19.11	......	......	......	6.01	14.01
9. Portugal, modern	54.02	20.00	1.45	......	......	9.76	4.76
10. Coarse earthenware	39.50	12.00	0.20	......	......	5.35	20.00
11. Coarse earthenware	36.50	10.50	......	......	......	5.40	25.00
12. Lucca della Robbia (Majolica)	49.65	15.50	0.17	......	......	3.70	22.40
13. Delfware	49.07	16.19	0.82	......	......	2.82	18.01
14. Persian	48.54	12.05	0.30	......	......	3.14	19.25
15. Rouen	47.96	15.02	0.44	......	......	4.07	20.24
Hard Body.							
16. Pallissy	67.50	28.51	......	Trace.	......	2.05	1.52
17. Henri II (F. d'Oiron)	59.10	40.24	......	......	......	......	......
18. Lunéville (terre de pipe)	67.39	16.00	1.02	Trace.	......	2.01	13.16
Very Hard Body (Fine Earthenwares).							
19. Creil (France)	66.10	32.20	......	1.10	......	0.55	0.14
20. Minton (England)	72.60	24.10	......	2.20	......	1.10	......
21. Wedgewood (England)	76.10	20.45	0.14	1.60	......	1.00	0.75
Very Hard Body (Stonewares).							
22. Vauxhall (whitish)	74.00	22.04	0.17	1.06	......	2.00	0.60
23. Wedgewood (yellowish, unglazed)	66.49	26.00	0.16	0.20	......	6.12	1.04
24. Chinese (reddish-brown, unglazed)	62.00	22.00	Trace.	1.00	......	14.00	0.50
25. Japanese (reddish-brown, unglazed)	62.04	20.30	Trace.	Trace.	......	15.58	1.08
Very Hard Body (Porcelains).							
26. Nymphenburg (Bavaria)	72.80	18.40	0.30	0.65	1.84	2.50	3.30
27. Meissen (Dresden)	58.50	35.10	Trace.	5.00	......	0.80	0.30
28. Limoges	70.20	24.00	0.10	†4.30	......	0.70	0.70
29. Sévres	58.03	33.94	......	2.97	......	......	4.58
30. China (first quality)	69.90	26.60	0.02	3.30	2.90	1.20	0.30
31. Japan (eggshell ware)	78.763	17.847	.029	.203	1.975	.638	.213
32. Japan (thick body porcelain)	74.545	19.315	.176	.566	2.832	1.916	.106
33. Piedmont (near Turin)	69.80	10.40	17.60	......	......	......	2.00

* Either not present, or if present they will have no effect at all, the pottery being baked at too high a heat *to affect them.*

† *Alkalies.*

TABLES OF PASTES.

Water	Carbonic Acid or Carbon	Glazes	Analyses Principally from Salvétat and Brongniart.
7.07	1.00		Scarcely baked at all; unusually low proportion of silica.
15.24	1.26		
		Sometimes lustrous	Soft, marl-body lime, probably as silicate. This is the general composition of the finest potteries of this class—very old. Sometimes with lustrous glaze, now proved to be composed of silica and alkali, with oxide of iron or lime, transparent glazes, sometimes black, probably iridium.
8.45	1.55		Many analyses of this Etruscan pottery upon great similarity, probably all made by about same recipe.
	1.68		
2.04	0.99		
10.56	.78		Not baked enough to drive out the carbon; very low heat.
2.06	5.77		Very low heat.
5.97	4.04		Very low heat.
7.30	17.50		These were analyzed before baking; only well dried, which accounts for the water; all lime-body.
6.00	20.00	Tin or lead	
	8.58	Tin glaze	Lime-body; this takes tin glazes very well.
	13.09	Tin glaze	Lime-body.
	16.72	Tin glaze	Lime-body; often has a borax glaze from trical.
	12.27	Tin glaze	Lime-body.
		Lead glaze	Pipe-clay or ball-clay paste. Most of his pottery had a tin glaze.
		Lead glaze	Ball-clay paste, with a little kaolin in it, and there is probably a little iron, etc.
		Lead glaze	Old fashioned French ball-clay body earthenware, often with tin glaze to make it harder.
		Boracic	Modern French flint-body; fine earthenware, made on English recipes.
		Boracic	Modern English flint-body; fine earthenware.
		Boracic	Modern English flint-body; when glazed with a soft lead glaze this is much like the old C. C. ware.
		Salt glaze	Iron-body.
			Iron paste; these soften in the heat of the hard porcelain kiln.
	Veilgrith	Earth alkali	Lime porcelain; no feldspar is used, but a good deal of lime. Roscoe gives passau kaolin 100; bode mais quartz 40; marble (lime) 10.
		Feldspar	Brongniart and Prossel give gypsum, not marble. The alkalies come from the undecomposed feldspar in the kaolin, or from the sand. The glaze is an aluminous lime-glass.
			Here is also made a hard body with a lead glaze. This is for decorative purposes.
Trace.	Laurent	Pegmatite	
			The Chinese glazes have a large proportion of lime, at least one fourth, and are more fusible than the European glazes.
	Würtz		Washed tsiji-chu-chi, 17 p. c.; washed shiro-chu-chi, 30 p. c.
	Würtz		Washed shiro-chu-chi, 50 p. c.; washed sakaimé-chu-chi, 50 p. c. These porcelains are very siliceous, and are more fusible than the European.
			A similar porcelain is made in Spain.

TABLES OF PASTES—Continued.

KINDS OF POTTERY.	Silica	Alumina	Magnesia	Potash and Soda (not separated)		Iron	Lime
34. Worcester	82.00	9.10	7.40	------	------	------	1.30
35. Sèvres (old paste, about 1760)	74.50	2.00	------	2.60	1.00	------	15.78
36. Sèvres (about 1856)	76.00	2.00	------	*5.25	------	0.75	16.00
37. Tournay	76.45	7.35	Trace.	0.39	6.00	------	11.20
38. Persia	90.00	1.50	0.80	------	------	1.50	3.00

* Alkalies.

TABLES OF PASTES—Continued.

	Carbonic Acid or Carbon	Glazes	Analyses Principally from Salvétat and Brongniart.
....	....	Boracic	.... The old English porcelains had flint-glass glazes; the modern have borax or boric acid in the glaze. No available modern analyses.
....	....	Lead	.Fritted body, flint-glass glaze, very soft and very brilliant. Soft porcelain will also take a lime-glass glaze.
....	....	Lead	...Fritted body; the soft porcelain made at Limoges on much the same recipe, has sometimes a borax glaze.
....	....	Boracic	.... A very good ware, stronger than the Sèvres, and suited to household use; also good for decoration.
.60	....	....	.... This is the analysis of an opaque, fritted paste, which, when sufficiently baked, produces a real translucent porcelain, having generally a silica-alkali glaze. In porcelain paste, as in all others, the proportions vary slightly at different times, but never to any great extent.

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RIVER MINING.

By R. L. Dunn, E.M.

River mining is a branch of placer mining that is carried on in the channels and beds of rivers and large streams. Practically it may be considered as including the mining of such deep bars as have to be exploited below the surface of the water in the adjacent river. River mining is not local to California, though undoubtedly carried on to a greater extent here than in any other gold-bearing district in the world. As contrasted with gulch and ravine mining and hydraulic mining, it is dry season work, only practicable when the rivers are in their low water stages. Probably no other branch of our gold mining industry is subject to more uncertainty under ordinary conditions than is river mining, yet in no other branch are as large returns possible with comparatively small capital. In the early mining history of California, after the rapid working out of the shallow placers of the high bars, attention was turned to the river channels as the next most certain source for a large gold yield, and in 1852, 1853, and 1854, a very large amount of this mining was done, and most of the gold yield of the State at that time came from this source. During these years all of the large gold-bearing rivers in the State were worked, but the industry gradually declined in relative importance with the discovery and opening of the mines in the old river channels. Hydraulic mining from 1857–58 practically extinguished river mining in many of the rivers by reason of tailings covering up the river claims, and it is only since 1880, coincident with the restriction of hydraulic mining, that the attention of mining men has been directed to the river channels.

The rivers which have been and are now the locality of this branch of mining, are the Klamath, Salmon, and Scott Rivers, Trinity River, and the main Sacramento above Redding, Feather River above Oroville and its four large forks, Yuba River above Smartsville and its main forks, Bear River, the North, Middle, and South Forks of the American River, Cosumnes River, Mokelumne River, Stanislaus River, Tuolumne River, and Merced River. Of these the Cosumnes, Mokelumne, Stanislaus, and Merced Rivers are practically worked out and abandoned, certainly so far as any large operation is concerned. The low water flow of these streams is comparatively small and easily controlled, and the tailings from hydraulicking did not get into the river channels until they had been thoroughly worked. The very little mining in these streams of late years has been by small companies of Chinese handling over tailings and the few unworked spots overlooked by the old miners. The South Fork of the American River, and Trinity River, are practically abandoned, though it is probable that in both streams there yet remain unworked portions of the bed that will pay. The large volume of water in the main Sacramento River above Redding has prevented work in that stream to any extent, and it is not likely that any successful mining on a large scale will be possible there till the low water volume of the stream has been materially reduced by diversion for irrigation. The remaining streams are thus practically the only available ones for this branch of mining. Of these the

Yuba and its forks, Bear River, and the North Fork of the American contain large areas of unworked ground known to be rich, but buried beneath large masses of hydraulic tailings. These tailings, however, contain in the aggregate a large amount of gold, and have thus enriched the river beds for future mining. The winter floods, with the cessation of hydraulic mining, are now ground sluicing on a tremendous scale, washing the tailings that have been slacking and disintegrating for years, and concentrating the gold they contain into a smaller bulk of gravel. A few years of this operation and these rivers can again be profitably mined.

The localities of active mining operations in this branch of mining at the present time are confined to the Klamath, Salmon, and Scott Rivers, in Siskiyou County; the Feather River in Butte County, and the Middle Fork of the American River in Placer and El Dorado Counties, with a little work by Chinese high up in the forks of the Yuba River.

Klamath River ever since the discovery of gold in its bed has been continuously mined and is still a long way from being worked out. The conditions for river mining in this stream are very favorable. Though carrying a large volume of water, it has nearly everywhere a considerable grade and velocity of current with no great depth. Hydraulic mining tailings have not accumulated and covered up the claims, and mining in it has been so continuous that the location of the worked and unworked portions of the bed are well known, and there is not the uncertainty on this point that is the case with the other noted streams. At the present time there are about twenty-five claims being worked on the Klamath and Salmon Rivers, employing three hundred men. Operations in this locality are generally on a small scale and involve the use of but little capital. The Feather River, in Butte County, is the location of the two most extensive river mining operations in the State. These will be considered in detail further on. The Middle Fork of the American River, though worked very extensively in the fifties, still contains much valuable ground, particularly in deep bars and in portions of the main channel that the early miners could not drain or bottom. A considerable amount of river mining is now being done at several points on this stream, and new enterprises are under consideration for the immediate future; the successful results of the present work having encouraged the investment of capital.

The rivers in which river mining is carried on run in narrow cañons more or less difficult of access. Usually the hill and mountain slopes rise directly from the water's edge, but the streams meander for portions of their course from side to side of narrow valleys, leaving small flats, or "bars," as they are termed by the miners, alternately on one and the other side of the stream. The formation of these bars is due to the action of the flowing river. During the period of its gradual erosion, slides from the hillsides, or the accumulating debris of floods, have changed the course and channel of the streams, and widened the cañons to narrow valleys. These bars, sometimes high above the present channel of the river, sometimes lower than it, are nothing but portions of its former bed. Often a secondary erosion so changes them that their identity is lost, but wherever they are, the dynamic and hydraulic forces that formed them made them natural riffles and storehouses of placer gold. These deep bars were the dream and the snare of the early miners, probably more effort and capital being expended in unsuccessful attempts to mine them than in any other of the early mining operations, the fabulous yield of the few successfully worked deep bars and adjacent river-bed encouraging similar undertakings, that were only abandoned after successive failure had demonstrated the inadequacy of the appliances and methods employed.

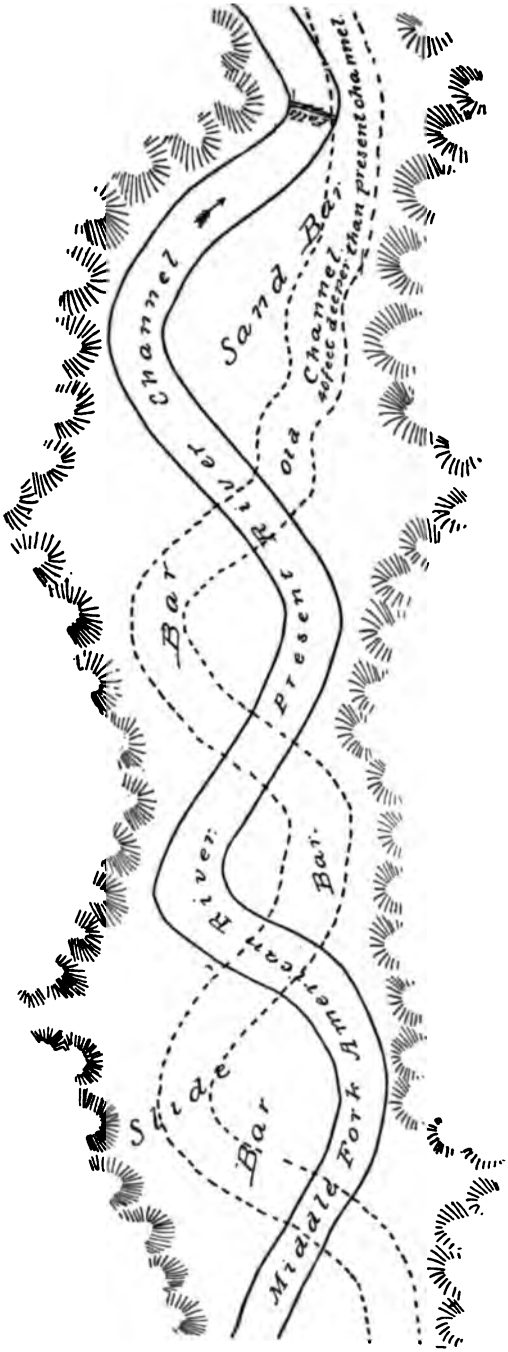

Channel
Sand Bar
Old Channel
20 feet deeper than present channel
Present River
Bar
Bar
Slide Bar
Middle Fork American River

diagram of a river channel used as an illustration is from a rough
of a portion of the Middle Fork of the American River, a few miles
Auburn. It is as good an example of "bar" formation as could be
. The lines dotted as old channel are, of course, only illustrative
tual, as but little of the surface of the bars has ever been removed,
at which has, if anything, indicates that the river at different times
everal lines of flow, and made corresponding erosions in the bedrock.
own on the diagram, but a few hundred yards further down stream,
endous slide at one time blocked the river, and probably caused the
ion of the bar marked "sandbar," and contributed more or less to
mation of the other bars. This slide, or another adjacent to it, left
ral dam and falls in the river, which have only recently been blasted
make possible the mining of the river-bed and bars shown in the
m. The present channel of the river is at points a short distance
the falls, thirty to fifty feet higher than the old channels as exposed
ning.

r mining is almost entirely a problem of restraining and handling
olumes of water. In the rivers it involves dams and pumps to con-
e water, so that the bed of the river can be exposed and mined. In
ar mining the river waters also require control and must be drained
nd their influx prevented, and it is this similarity of condition that
it desirable to consider both under the general term "river mining,"
the appliances employed for the latter are of a more permanent
ter and involve the outlay of more capital than is required for the
.

season during which river mining is possible begins with the reced-
the flood waters in spring, and continues until the first rains in the
se the waters again. Sometimes this first rise does not destroy the
plant in the river-bed, and a period of low water following lengthens
son till the winter storms come. The season is therefore an uncer-
antity, varying from year to year, and different in different streams.
e Klamath River and its tributaries the season is given as eight
s, beginning about the middle of March or the first of April, and end-
out the first of December. On the Middle Fork of the American it
about the first of May and continues till the first of November,
, though sometimes shut down as early as October, and sometimes
l the end of December. In the Feather River the season is even
, it not ordinarily being practicable, on account of the large water
begin operations before the middle of May, nor to continue them
e first of November. The time that can be given to actual mining
king out of gold is, however, only a comparatively short part of this
. From the nature of the appliances required and their location in
er-bed they have to be put in anew for every season's work, and
tly the work of fitting up leaves only a few days for mining before
ing waters sweep away in a few hours the work of months. Ten,
, or thirty days is not uncommon as the time employed in actual
, but yields of from $500 to $5,000 a day for this time are often real-
paying well the labor and expenditure of fitting up.

r mining, considered with reference to appliances for working, can
sidered under subdivisions, as follows:

iver mining by temporary wingdams, an upper and a lower cross-
nd a connecting dam in and aligning with the stream, reclaiming a
of the river-bed for mining, and forcing the waterflow to the oppo-
le of the channel without raising the level of its flow materially.

2. "Fluming," or river mining with two temporary cross dams and a temporary flume laid as near the low water level of the stream as practicable, into which the entire flow is diverted by the upper dam and conducted over the lower. By this method the water level behind the upper dam is only raised from three to four feet.

3. River mining with an upper dam raising the water level above the ordinary high water line, diverting the entire flow into a flume or tunnel of permanent character. The upper dam may or may not be designed to be permanent.

4. River mining through permanent shafts, hoisting and pumping plant on the banks of the stream, and mining by drifting under the channel.

5. River mining by elevators, dredges, vacuum pumps, and all similar plants, placed usually on a barge or float, and working underneath the surface of the water.

6. Deep bar mining by shafts and drifts.

7. Deep bar mining by stripping and "pitting," employing either steam or hydraulic lifts or elevators.

WINGDAMS.

River mining by wingdams is the usual method where the volume of water is too great to be flumed. At the present time it is the method exclusively employed on the Klamath River. Considerable of the old mining on the Feather, Yuba, and American Rivers was done by the construction of such dams, but they are seldom seen there now, except where small companies of Chinese are at work.

The wingdams made for mining are temporary structures, made usually at a cost only of the labor employed. For the "head" (upstream) dam the upper end of a riffle is selected if possible, and two parallel walls of bowlders are built, not less than six feet apart, and the space between filled in with gravel and sand, the former nearest the outer wall, as sand would gradually wash through the spaces of the bowlder wall and the dam would not be tight. When these walls reach about the middle of the stream, or as far out as it is desirable to mine, they are turned down stream and continued to the lower limit of the ground to be inclosed, then turned, on a riffle if possible, and the "tail" (down stream) dam built, connecting with the same side of the river from which the head dam sets out. Considerable care is required in filling between the walls, in order to make a tight dam. The mining ground thus being walled in, its drainage is then effected by what is now commonly known among miners as a Chinese pump, located at the lower end of the mining ground or in its deepest hole. The motive power for this pump is the current of the stream. An undershot waterwheel is built and placed in the stream alongside of the dam, so that the current impinges directly against the paddles. The pillow blocks on which the shaft rests are made of piles driven in the bottom of the river and buttressed by as large bowlders as can be placed against them. The pillow blocks are not fast, but work in vertical slides and can be raised or lowered by levers, so as to control the running of the wheel. If necessary another wingdam is built out from the other side of the river, to turn the force of the current still more against the wheel. This wheel being very liable to be swept away and lost when high water comes, is constructed as simply and cheaply as possible. For the shaft a twelve-inch square timber is used, the ends rounded and protected with iron rings, into which the gudgeons of the two or two and one half inch cast journals are driven. The diameter of the wheel is usually ten or twelve feet, and the width, dependent on the work it has to do, from eight to

ıteen feet. The arms are made of two by four scantling, sometimes ticed into the shaft, but preferably spiked to flanges made of doubled ı boards from sixteen to twenty inches deep. Three or four sets of lve arms each are placed on the shaft, this depending on the width of wheel, and paddles made of inch lumber and twelve inches wide dip the current. The journals turn in seasoned oak boxes resting on the ow blocks. A wheel so constructed can be broken to pieces quite rap- and the shaft, the valuable part, saved for another season's work when ould not be possible to save the wheel entire. Between the wheel and pier on the side toward the dam, is the gear connecting with the counter ft, usually a rubber or leather belt running on a wooden drum three in diameter and with a twelve to twenty-four-inch face, which runs pump. The pump is simply an inclined box made of one or one and half inch lumber and from sixteen to thirty-six feet long; attached in ıt the bottom and under the water is another drum not as large as t on the counter shaft; over these two drums and through the pump or barrel runs a tight rubber or canvas belt, from twelve to twenty-four hes wide, dependent somewhat on the quantity of water that must be ıdled, and specially prepared, if the latter material is used, to resist ing and the grit of the water; on the outer side of this belt, three feet rt, are fastened paddles three to six inches wide, and of length equal the width of the belt. The belt and these paddles just fill the pump , the lower end of which being open under the water surface and the er end opening into the discharge flume or box, a continuous stream of er of large volume is pumped or elevated. For lifts of from twelve to nty feet this style of pump is very effective, and water is frequently ated thirty feet by means of them. Some of the larger of these pumps ıdle fifty inches of water. With one or more of them to clear and to p clear the area inside of the wingdams, the ground is ready for mining. only appliance required for this, other than picks, shovels, wheel-rows, and sluice-boxes, is a derrick. This consists of a stout mast sixty ne hundred feet high with a boom guyed with six wire ropes. It has usual blocks, tackle, and windlass, and its utility is in handling large lders, clearing away waste for the pit, and in lifting gravel to the ces, though this last is more often done with one or more lifts of shov-ıg or by wheelbarrows. Where much work is done with the derrick it y be operated by a small current wheel similar to that already de-bed. For the washing of the pay gravel a small stream of water is let hrough the head dam. Should it not be possible to get sufficient grade the sluices and their discharge over the tail dam, what is termed a dip eel is used to raise the necessary water; this is a wheel run by the cur-t, but of larger diameter, twenty to twenty-six feet, and less width, four ight feet, than the wheel used for pumping; on one or both ends on the iphery are buckets that, with the revolution of the wheel, dip up water l discharge it into the washing sluices.

he gravel containing gold is almost invariably right on the bedrock and ts crevices. The depth of the pay varies, sometimes being fifteen or nty feet and sometimes only a few inches. Overlying the pay is a mass owlders and gravel, containing little or no gold, which is removed by derrick or barrows till a pit is excavated down to the pay gravel. This hen taken out down to the bedrock and washed, the bedrock being care-y creviced and cleaned. The area of the cleaned bedrock is then util-l to pile bowlders and as a dump for the stripping of fresh ground. The eral experience of river miners has been that the riffles contained the

pay gravel, while the deep holes were comparatively barren of gold. Crevices in the bedrock are often wonderfully rich.

The shortness of the season available for work compels the use of the nights as well as the days, large pitch-pine fires or oil lanterns being used for illumination. When the ground inside of the dams is worked out, or the rising water stops work for the season, the claim is dismantled and as much as possible of the plant saved. The derrick is first secured, then the pumps, belts, wheels, and sluice boxes.

The cost of fitting up a claim with wingdams, wheels, pumps, derricks, and sluices, and the excavation of the pit to pay gravel, is sometimes as low as $500, occasionally as much as $5,000, and a safe average of experience places it anywhere from $2,500 to $5,000.

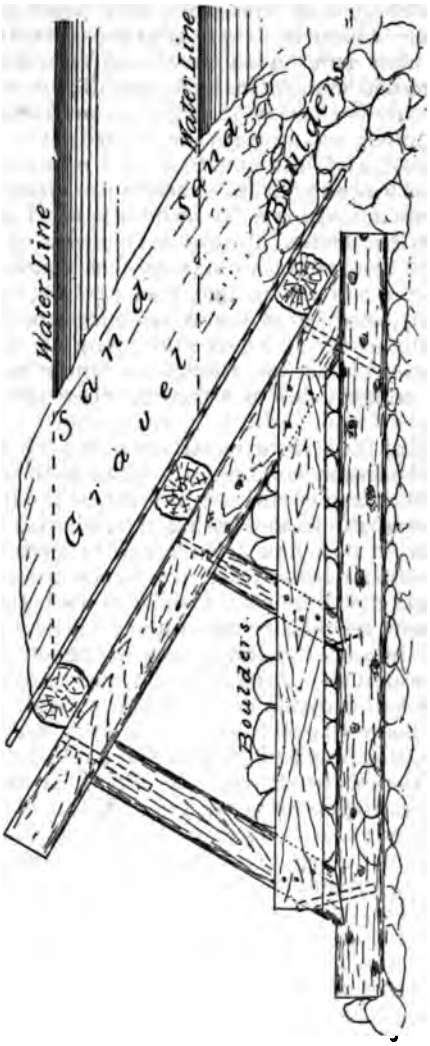
FLUMING.

Fluming, or river mining with head and tail dams across the entire width of channel of the stream, and the diversion of the latter into a flume, is a more expensive and uncertain operation than mining by wingdams, yet much better suited to extensive operations than the other. Where it is possible to mine portions of the bed of almost any stream by means of wingdams, fluming can only successfully be done in the smaller rivers. In the fifties, when river mining was at the extreme height of its importance and prosperity, combinations of several companies of miners working adjacent claims, frequently flumed the smaller rivers for miles and worked every foot of the channel.

The season for flume mining is shorter than that for wingdam work. This is occasioned by the necessity of constructing the flume first, and as the flume cannot be built under water, it is necessary to wait till the river is close to its low water stage before beginning construction. The water in the Feather and American Rivers is usually low enough to begin the construction of a fluming plant between the first and fifteenth of June, though some years it is possible to commence as early as the first of May.

The flume is built on one or the other side of the river as is most convenient, right in the water, in order to have it as low as possible. The dimensions are dependent on the volume of water it is expected to carry. On the North and Middle Forks of the American River, above the junction, from eight to twelve feet was the usual width; below the junction in the North Fork eighteen and twenty feet, width was found necessary. In the Feather River at different points twenty-four to thirty-two feet is required, and in Bear River four to six feet was found ample. The depth of the boxes varies from three to five feet. The grade given should not be less than three inches to one hundred feet; a rapid flow being desirable to give the necessary power for current wheels, and to lighten the weight on the flumes by keeping the depth of flow low. The whole construction is of the most temporary character. Stringers ten by twelve or six by ten, rough pine logs smoothed by the ax, are laid about four or four and one half feet apart, and posted up where necessary; on the stringers are laid the sills or cross-ties, four by four scantling, three feet apart; the uprights, of scantling, are cut round at the foot, and driven into two-inch auger holes in the ties; the wider flumes are braced from the ends of the cross-ties, and the narrower by strips nailed on the tops of the uprights. The bottom and sides are made of inch boards. Experience has found such a flume able to carry water five feet deep without showing any evidences of weakness or giving way. The head and tail of the flume require the most care and attention *as regards* construction, owing to the danger of leaking or of undercuttings.

e head the flume is flared out with a gradual taper to nearly double egular width and projects beyond the line of the head dam from nine elve feet, the third or fourth cross-tie being brought into exact line the stringers or plate on the inclined frames of the dam; before the is floored boards are driven down from this tie to the bottom of the m on the slope of the planking of the dam, so that the jointing with it be tight. Large rocks, gravel, and finally sand are immediately



Cross Section Timber Dam. Scale ¼ in. to 1 foot.

vn in on the foot of these inclined planks, to keep the current from rcutting, and the entire space in front of them to the head of the e is then filled up solid with rocks and gravel before the floor is laid. ie tail end of the flume, in the line of the tail dam, before the floor is two lines of planks are driven down vertically from two of the cross-

ties, six feet apart, and the space between filled up with bowlders and gravel, and made a part of the dam.

As soon as the flume is built the construction of the head dam is made. This is a timber dam, but being temporary, and only calculated to sustain the pressure of from two to four feet of water, it is constructed of the cheapest and most accessible materials, as far as possible. The pines on the adjacent cañon slopes furnish the timbers. These are roughly squared and faced with the ax. For the location of the dam the upper end of a riffle is preferable. Frames or bents are first made of timbers eight to twelve inches square. These bents are triangular, and consist of a mudsill ten to eighteen feet long, to which, at one end, the inclined sill or stringer plate is trenailed with a two-inch trenail, the angle between the two timbers being made from 30 to 45 degrees, the frame being then completed by a brace timber set at right angles with the inclined sill and footed into the mudsill, and fastened to both by two-inch trenails. For large frames a second brace is put in. Boards are spiked each side of this frame above the mudsill, making a box, which is filled with bowlders, and enables the frame to be floated upright into place. The placing of the frames, which are set from eight to sixteen feet apart, dependent on the depth of water and force of the current they are set in, is commenced at the head of the flume, care being taken to secure a perfect alignment, in order that the bearing of the stringers and planking shall be evenly distributed. If the current is not too strong, the frame can be put in place by two or three men on each side of a frame; otherwise two ropes are fastened to the nose of the frame and the frame snubbed into place from the river banks. The bed of the river on which the mudsill is seated is smoothed off with a crowbar, the frame weighted into place with bowlders, and temporarily tied to the other frames with strips until all the frames are in place. On the inclined slope of the frames stringers are laid. These are timbers as long as they can be cut, and from eight to twelve inches through between the ax-smoothed sides. These are laid on the inclined sills above the water's surface and forced below it as near to the bottom as possible, the pressure of the current keeping them in place without further fastening. A second stringer is then laid on the frames about four or four and a half feet above the first, which will bring it at the surface of the water usually, and then a third an equal distance above the second. The dam is then planked with inch boards twelve to sixteen feet long, according to the depth of the stream, the planking commencing at the flume and going toward the opposite side of the stream. An expert can push a plank down, edge to the current, until bottom is reached, when it is turned and forced into place with the current, or the boards can be slid down the stringers to the bottom, no fastening being required to keep them in place. As the laying of the planking progresses, large bowlders and gravel are dumped at its foot from a temporary staging, to prevent the current undercutting, and as soon as the planking is completed, bowlders, gravel, sand, and earth are wheeled in and dumped against the planking until the dam is tight and all the water flows through the flume. The tail or foot dam is then constructed, on the lower end of a riffle preferably. Two walls are built of bowlders and large rocks, not less than six feet apart, and filled in between with sand and gravel, the construction being similar to that of wingdams as already described. A tail dam is not always essential, as a riffle may protect the pit against back water. With the completion of the tail dam the pit is ready to be cleared of water. One or more undershot waterwheels are set up in the flume and driven by the current. These *furnish* power for the Chinese pumps, derrick, and, if used, the electric

light plant for working the claim at night. The opening of the ground by pits and the mining out and washing of the gravel has been already described in connection with the method of river mining with wingdams. The ground is mined out underneath the flume and head dam by putting in posts as fast as the support of the ground is cut away. A slight rise of the stream does not necessarily close down mining by wingdams, as the portion of the channel occupied by the water-flow is so large that it may carry the additional water of the rise without overtopping the dams; but in fluming a slight rise may overtax the capacity of the flume and fill the pit. In fluming, the material put into the dam is almost certainly an entire loss at the end of each season; also, it is not expected that any of the flume will be saved. With good luck, the wheels, pumps, derricks, and lighter plant may be taken out of the river and saved over from one season until the next.

The cost of fitting up a fluming claim from year to year cannot be given with even approximate accuracy, as unforeseen contingencies enter largely into it with every different claim, and in different years with the same claim. It is safe to say, however, that this expense, except in very small operations, will not be less than $3,000, and may be $10,000.

PERMANENT FLUMES AND TUNNELS.

River mining, in which the water is first raised above the high water line by the head dam and then diverted through a permanent flume or tunnel, necessarily requires a considerable outlay of capital, and is only expédient when it is thus possible to drain and open for mining a large extent of river-bed that will require several seasons to thoroughly exploit, even under the most favorable conditions. If a permanent head dam be put in, the season available for work is much lengthened, for as soon as the flow of water reaches the low water stage the river clears itself by diversion into the permanent flume or tunnel. Pits can thus be sunk and mining commenced at a time when, under the usual methods of fluming, the first work of building the flume would only be beginning. Three operations of this class are under way in this State. The Golden Gate Alluvial Syndicate (limited), on the main Feather River, three miles above Oroville, the plant there being a permanent flume with a temporary head dam. The Big Bend Tunnel, on the North Fork of the Feather River, sixteen miles above Oroville. The plant there is a permanent head dam and permanent tunnel draining thirteen miles of river-bed for mining. The Horseshoe Bar Claim, on the Middle Fork of the American River, just below the town of Michigan Bluff. At this claim is a tunnel, the diversion of the stream being directly into it through a shaft. Over a mile of river-bed is thus drained. All three of these merit some detailed consideration.

GOLDEN GATE ALLUVIAL SYNDICATE (LIMITED)

This mine, commonly spoken of as the Golden Gate River Mine, is, as already noted, on the main Feather River. An attempt was made to work this mine in the season of 1889, which was unsuccessful, by reason of contingencies that were not and could not be foreseen and provided against. The ground that the attempt was made to mine comprised three thousand two hundred feet of river-bed, having an average width of channel to be mined of one hundred and fifty feet. The head dam put in for the season, instead of being a light structure, such as has been described, raising the water level at the most but three or four feet, was a comparatively solid

structure, raising the water level fifty feet and diverting it into a flume above the high water line. The plant and its construction were as follows:

The sites for the head and tail dams having first been selected, the grade for the main flume was constructed in the winter. Early in May the construction of the flume was commenced. This at the head was made fifty feet wide, tapering in eight hundred feet to the regular width of thirty-two feet. The sides were built five feet high, and it was given a grade of one inch to sixteen feet. In construction, three stringers, eight by eight, spruce timber, were laid, and on these cross-ties six by six and four feet apart. Where there was not sufficient rock bearing, the cross-ties as well as the stringers were posted up. For uprights four by six timbers were used, braced by four by four scantling from the ends of the cross-ties. The bottom and sides were planked with one and one-quarter-inch boards. The tail end of the flume discharged on a bowlder bank, the cutting effect of a high drop being avoided by increasing the grade of the last boxes. The depth of water flow in this flume at extreme low water was two and one half feet, and its velocity eighteen feet a second, indicating a flow of one thousand four hundred and forty cubic feet a second, or seventy-two thousand inches under a four-inch head. This construction employed twenty-five to thirty men and was finished in the middle of June, and the construction of the head dam immediately begun. This had been delayed six weeks by the May storms. The dam was made of cribs ten to fifteen feet square, the dimensions being on the bottom ninety feet across the stream and sixty feet wide, and two hundred and fifty feet long by twenty feet wide on top, the height of the main dam being forty feet, and of the frames on top of this ten feet. The cribs were made of peeled pine poles ten or twelve inches through at the butt and twenty to forty feet long. They were cut above the dam and floated down. The framing was spiked together with wrought iron spikes. The water slope of the cribs, one horizontal to four vertical, was planked with two-inch boards. The dam was only kept tight enough to raise the floating poles within convenient reach for construction as they were needed, the water being allowed to run through the structure till it was completed. The cribs were filled in with rock and gravel brought from both banks of the river by a temporary handcar track. On these cribs was built the upper ten feet of the dam of eight by eight timber frames, such as have already been described, and through it was a waste gate ten by forty feet. This gate was intended to let that portion of the first fall rise in the river, usually coming in October, through the claim, should the flume fail to carry it. The first October rise of 1889, however, proved too large for it, and a portion of the head of the flume was swept away. The dam when completed was made tight by dumping in gravel, sand, and earth on the boarded water slope. The construction of this dam required seventy thousand linear feet of pine poles, and twenty thousand tons of rock and gravel, and it was finished August thirteenth.

The tail or foot dam was made of a single line of nine by nine feet cribs, and filled in with rock and gravel. Its height was from four to six feet. This dam and the construction of a subflume in the bed of the river were made at the same time. The object of the subflume was to carry off the seepage through the dam and that pumped from the pit. It was built four feet wide and three feet deep on a grade of one fourth of an inch to sixteen feet. The pumping plant consisted of two elevators, two Chinese pumps with boxes three by twenty-eight inches, and a centrifugal pump. The lift for the pumped water was twenty-eight feet. The elevators had columns or barrels eleven inches in diameter, with a ten-inch throat, this latter proving too large for good work. They were operated with two hundred

DAM UNDER CONSTRUCTION.

DAM COMPLETED. HEAD OF FLUME.

and seventy-five feet head of water from the Palermo Ditch. One of t with a two and one half-inch nozzle, used one hundred and seventy-five inches of water; and the other, with a three-inch nozzle, took two hundred and eight inches. The mine was ready for pumping on September first, but no water could be had for the elevators till in October, after the first rains. Meanwhile the other pumping plant had been put in, and was run by three overshot waterwheels—one eighteen feet in diameter and four feet wide; the other two (found too small) were twelve feet in diameter, with the same length of bucket. The construction of this plant, and further delay caused by the damage to the head of the flume from the first rise of the water, made it the eighteenth of October before the pit was pumped out and the ground prepared for mining. On this date the second October rise came so suddenly and unexpectedly that the head dam was overtopped and the plant in the bed of the river swept away before any mining had been done, and before any of the plant could be saved. Nothing was learned regarding the depth or richness of the pay gravel. The dam stood till the water flowed over it four feet deep, when it gave way, and has been washed out completely. It will be noted that the season for mining, or rather for putting in the plant, was unusually short, being only from the middle of June till the middle of October (four months), where usually it would be from the first of May till the first of December, or seven months. The total contract cost of plant and fitting up has been given to me as $100,000.

That this portion of the main Feather River is rich is well known. Though it has been worked considerably by wingdams, there is only one instance of successful fluming. In 1857 the Cape River Claim (the present Golden Gate ground) was flumed for three thousand two hundred feet, at an expense of $120,000. Only forty days were available for work before high water came and shut down the mine, yet in that short time $680,000 was taken out, single day's products reaching as high as $21,000.

BIG BEND TUNNEL.

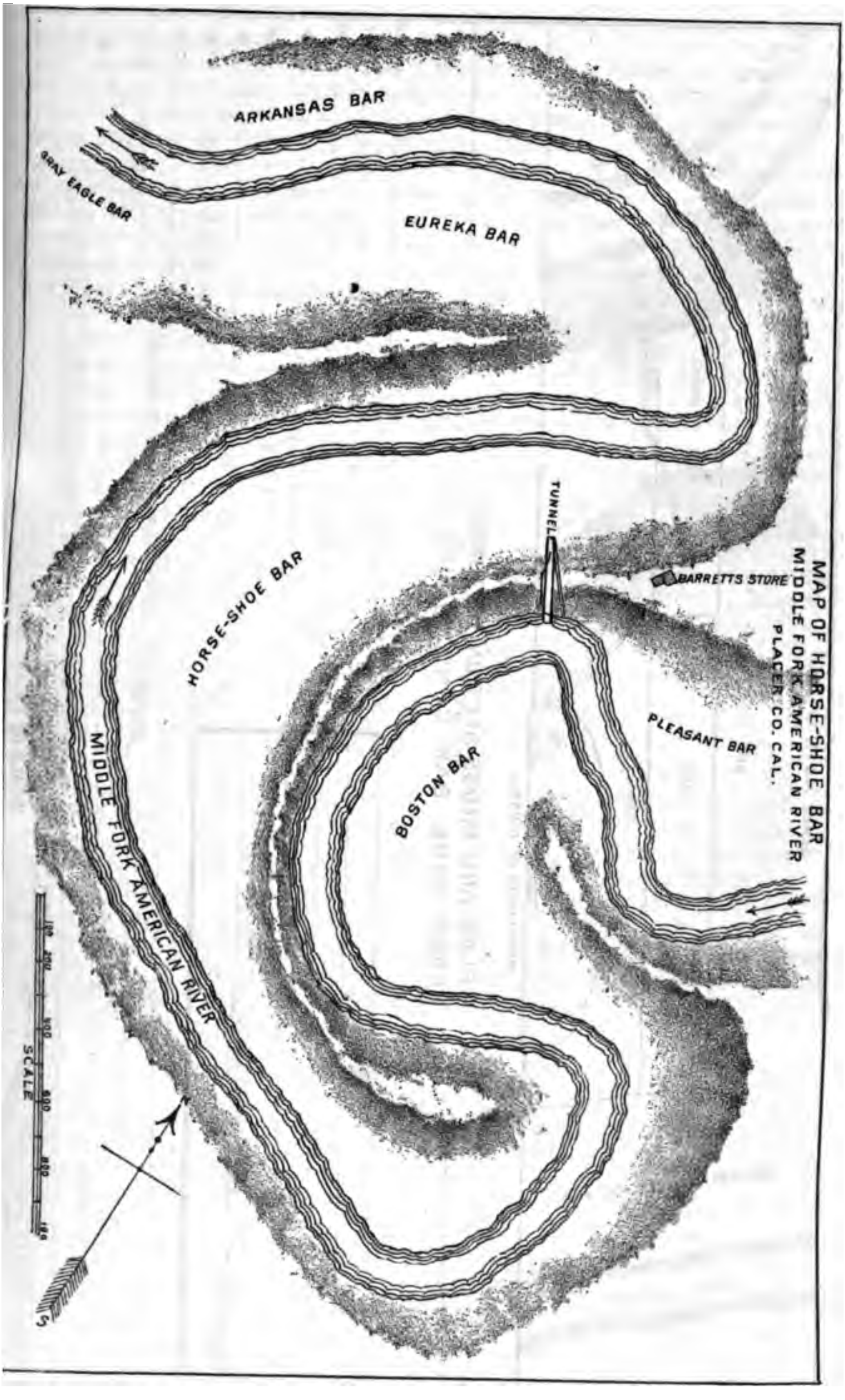
This is unquestionably the most important river mining enterprise ever undertaken, both as regards the amount of capital employed and the area of river-bed developed for mining. The North Fork of the Feather River is the largest individual stream in the gold mining district of California. Both above and below Big Bend it had been mined by wingdams and fluming, and the rich returns obtained demonstrated its great richness. That portion of the channel in Big Bend was reputed not to have been so extensively mined, but the small portions of the bed and bars that had been wingdammed and flumed were known to have yielded equally as rich returns as the more accessible portions of the river-bed referred to. The topographical character of this portion of the channel is more than ordinarily rough, and the cañon all but inaccessible. The channel of the river forms roughly three sides of a four-mile square, and the fourth, or land side, is penetrated by a ravine known as Dark Cañon from the west branch of the Feather River, which joins the North Fork below the Bend. From this ravine a tunnel line, twelve thousand feet long, was projected on a grade of thirty feet to the mile, coming into the North Fork at the upper end of the Bend. The construction of this tunnel (the preliminary work of building roads, buildings, and engine plant having been first completed) was begun in November, 1882, and finished in April, 1886. The plant comprised a No. 4 Burleigh air compressor, arranged to be driven either by steam or water

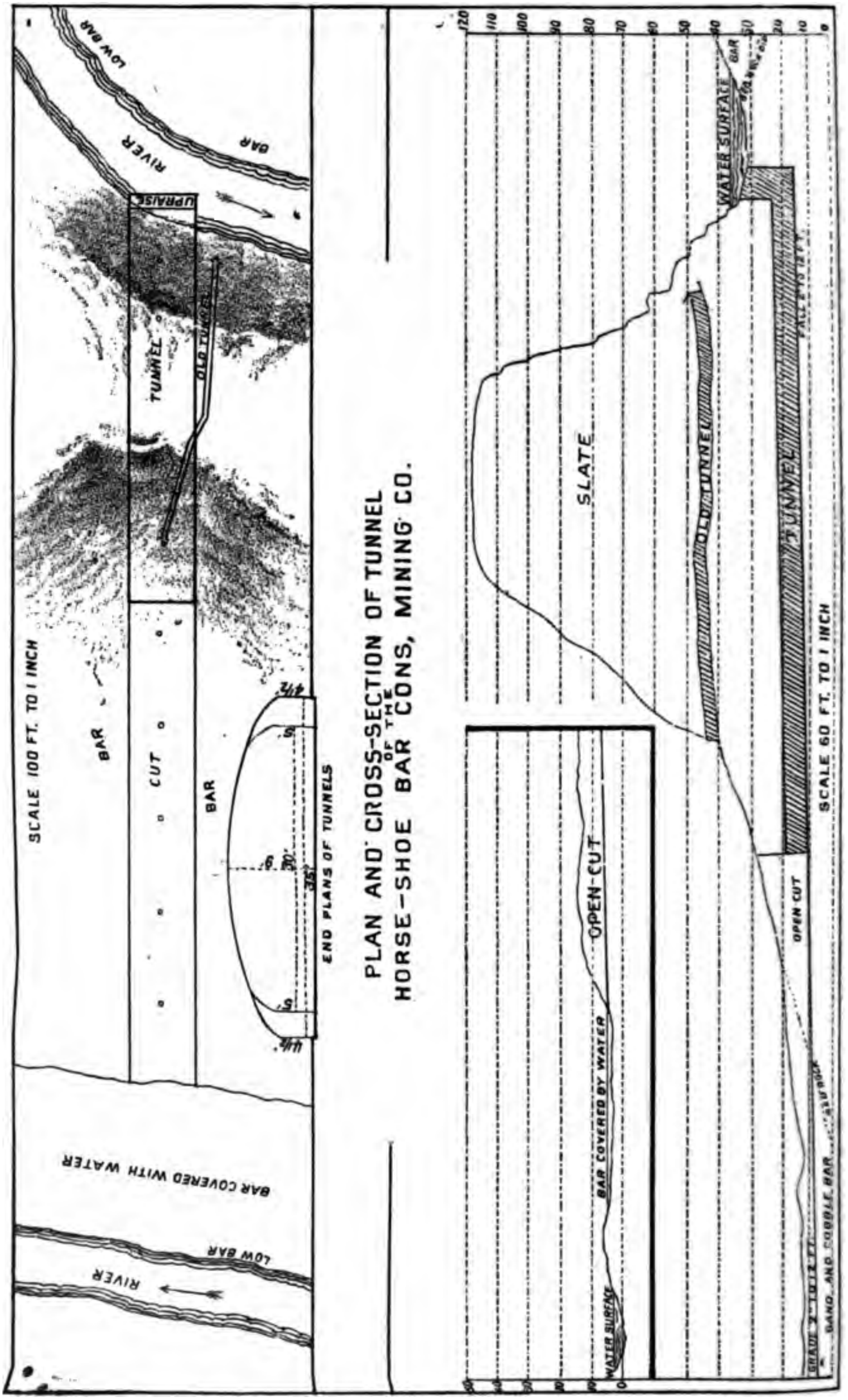
power, with a four by sixteen air tank; subsequently a No. 4 Clayton duplex compressor was put in; four Burleigh tunnel drills mounted on a Buffalo drill carriage; for steam power, a four by sixteen boiler; for water power, an eight-foot Knight wheel, using one hundred inches of water from Dark Cañon under two hundred and seventy-five feet head; a No. 3 Knowles pump; a two by eight Llewellyn heater; a No. 5 Baker blower and engine; and tunnel cars and mules for hauling them. The tunnel was first constructed nine by sixteen feet (the original estimates, however, were for twenty-five and one half feet width and twenty-one and one quarter feet height), but on completion, being found too small to carry the water flow, the height was increased to sixteen feet. The rock penetrated is slate of varying degrees of hardness, with occasional stringers of quartz and granite (probably diorite). In only a few places did it require timbering, a remarkably fortunate circumstance, for had soft rock been encountered it would have proved a very difficult problem to keep the tunnel in condition for water to flow through it. The larger amount of powder used was of the No. 1 Giant grade, the loading of the holes varying, of course, with the hardness of the rock. As a whole, the running of the tunnel was remarkably uniform, being as follows:

Distance run by hand prior to November 18, 1882	26 feet.
Distance run by drills between November 18 and December 31, 1882	373 feet.
Distance run by drills between January 1 and December 31, 1883	3,503 feet.
Distance run by drills between January 1 and December 31, 1884	3,090 feet.
Distance run by drills between January 1 and December 31, 1885	3,855 feet.
Distance run by drills between January 1 and April 12, 1886	1,155 feet.
Total	12,002 feet.

The head of the tunnel was flared out to thirty-two feet and given an increased grade, the floor being left four feet lower than the bed of the river, to give still more initial velocity to the water flow. The water was first turned into the tunnel by a temporary dam, and a permanent dam, one hundred feet base and sixteen feet high, then put in. The tunnel entrance is closed during high water by heavy castiron gates and all the water allowed to flow through its natural channel.

The seasons of 1886 and 1887 were lost for mining by reason of the necessary enlargement of the tunnel already referred to, but the seasons of 1888 and 1889 were utilized. In 1888 an attempt was made to utilize the water power at the Dark Cañon end of the tunnel for mining in the river-bed, an electrical plant being put in for that purpose. It seems not to have been very satisfactory, the complaint being uncertainty of control, and it was abandoned after that season's trial. Financially, that year's mining was not successful, the pits opened showing that the sides of the river had been wingdammed at those points more than had been supposed, and that the deeper ground in the unworked center of the channel contained but little gold, the bedrock being hard and washed smooth. In the season of 1889, a small force was worked and some gold taken out, but nothing commensurate with the outlay of capital already made. It is claimed that the river-bed is so choked and filled with enormous bowlders beyond the power of derricks to handle, that the little gravel between and under them, though undoubtedly rich, cannot be profitably mined. Of this I have no personal knowledge, but it seems that, though no such enormous returns can possibly be had as were expected from the preliminary examinations, there is no reason for abandoning the enterprise yet.


MAP OF HORSE-SHOE BAR
MIDDLE FORK AMERICAN RIVER
PLACER CO. CAL.
ARKANSAS BAR
GRAY EAGLE BAR
EUREKA BAR
TUNNEL
BARRETTS STORE
HORSE-SHOE BAR
PLEASANT BAR
BOSTON BAR
MIDDLE FORK AMERICAN RIVER
SCALE
S



PLAN AND CROSS-SECTION OF TUNNEL OF THE HORSE-SHOE BAR CONS. MINING CO.

HORSESHOE BAR RIVER MINE.

This is practically a similar operation to the Big Bend just described. The Middle Fork of the American River, just below where Michigan Bluff is situated, is a small stream in extreme low water, flowing about one hundred and fifty cubic feet a second. As will be seen by the map, the meanderings of the river channel around hard reefs of slate give a specially favorable chance to drain the river-bed by a tunnel. This has been twice attempted, but the first tunnel (the upper in the detail plan) was too small to carry the water and higher than it needed to be. The lower tunnel constructed during the last four years is entirely satisfactory. No dams are built, the river flow being allowed to go through the tunnel, which is only two hundred and eleven feet long, all the year. The inlet end of the tunnel is a shaft thirty feet deep in the river-bed. The value of this mining proposition seems to be more in the bars than in the river-bed itself, which had been flumed and worked out. These bars are deeper than the present channel of the river and have never been bottomed except over very small areas, which have proven rich enough to warrant their thorough exploitation.

Nothing more than the construction of the tunnel has as yet been done, the mass of sand and gravel overlying the pay gravel on the bars being so great that pitting by the usual method of hand labor is both too uncertain and too expensive to be advisable. The method of work approved and decided on by the owners of the property is the use of hydraulic elevators run by water under high pressure. This will require either the construction of a ditch several miles long from the river above the mine, or the obtaining of the water from the Georgetown system on the south side of the river. This latter has heretofore been unable to furnish the necessary supply, and thus delayed the working of the mine.

RIVER MINING BY DRIFTING.

This method of mining involves the sinking of a shaft in solid ground out of reach of high water, placing in it a hoisting and pumping plant, and then drifting out from the bottom under the flowing river into the pay gravel, which is then taken out through the shaft. This method is to be condemned, though it has been moderately successful in a few instances where very deep ground had to be bottomed. It is next to impossible to keep the underground workings from being drowned out or from being caved in. A river-bed with its quicksands and loose gravels and bowlders is naturally very unstable and unsafe to work under.

RIVER MINING BY DREDGERS, ETC.

Numerous attempts have been made to mine the river-beds from floating scows or platforms by means of dredgers and various styles of pumps, or combinations of the two. A barrel or cylinder lowered to the bed of the river and from which the air is exhausted, and the auriferous sands and gravels then forced in by the atmospheric pressure, is a favorite device with the purely theoretical river miners. The cylinder filled is then lifted to the boat by a derrick and the contents discharged into sluices and washed. If there is gold in the gravel some is necessarily brought up from the river bottom and obtained. These vacuum lifts, pumps, and dredgers are, however, practically unsuccessful by reason of the conditions under which the gold exists in the river-beds, and these conditions have been so thoroughly developed in all the trials made of this boat mining, as it may be called,

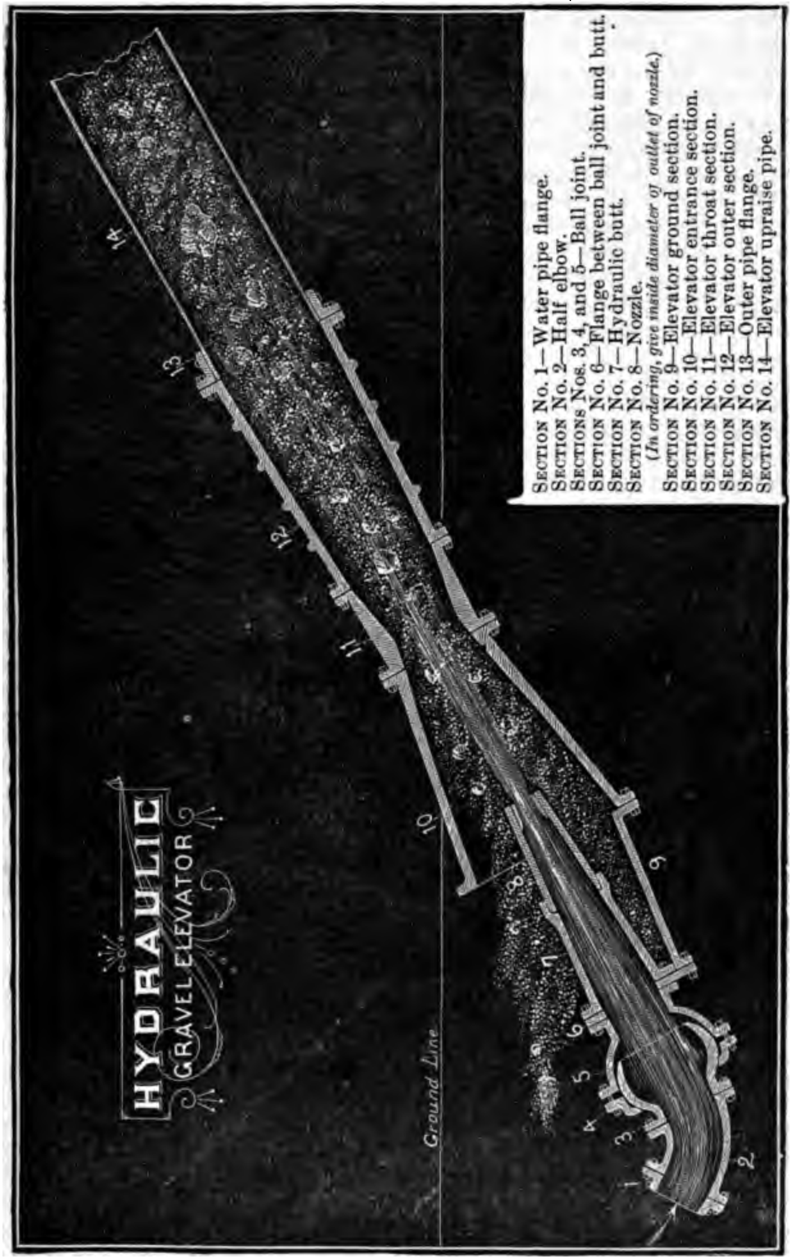
that the method can be unqualifiedly condemned without the expense of a practical trial. It must be evident that it is impossible to either clean bedrock or to crevice it by any of these devices, and it is on and in the bedrock that the larger amount of the gold is to be found. Also, it is impossible to work around or under large or even moderately sized bowlders. In a river-bed, where the bowlders are very large and form the bulk of the ground to be handled, these boat machines are useless. Where there is a considerable depth of light gravel it is difficult to excavate a pit, the sides being caved in by the water and the discharged tailings sliding back. With the river muddy, as mining streams usually are, operations are entirely blind. Work is of necessity confined to low water stages, and there is considerable difficulty in saving the plants from damage or destruction by high water.

BAR MINING BY DRIFTING.

This method of bar mining has been very commonly employed for deep ground. It is in every respect drift mining rather than river mining. The opening of the mine is a shaft in solid ground, with the usual equipment of hoisting and pumping plant. Like drifting under a river-bed already described, it is subject usually to the disadvantages of soft ground overhead, and a large amount of water. Considering only the unworked ground on our California rivers, it is a more desirable method for temporary prospecting than for permanent work. The inflow of water increases with the extent of the underground opening of the drifts. In prospecting but little expense is incurred for plant. The shaft is made circular, and only large enough for a man to work in. The hoist is a windlass and bucket, also used to keep the shaft clear of water. If the amount of water proves too large to be handled by the bucket, a common lift pump, such as is used in wells, is employed, but very seldom anything more permanent or costly. It sometimes happens that no water-bearing seam is cut in sinking, making it possible to mine out a considerable area at the foot of the shaft, and to extend the operation beyond mere prospecting of the ground. For deep bar mining, where the bar is deeply covered by a slide, drifting from the foot of either a slope or vertical shaft is the only practical method that can be employed. At the best, it is expensive and uncertain work. The pump plant should be made at the outset ample to handle any probable increase in the water flow as the extent of the drifts is increased by mining.

DEEP BAR MINING BY ELEVATORS.

Where it is possible to obtain large heads of water under considerable pressure, the mining of deep bars (except where covered by slides) and extended areas of river-beds that have been opened by fluming, is most economically and rapidly effected by means of what are called hydraulic elevators or lifts. This style of plant has already been incidentally referred to in connection with the Golden Gate and Horseshoe Bar Mines. These elevators consist of a wrought iron upraise pipe or barrel, of diameter dependent on the vertical lift and water pressure available, those at present in use being from eleven inches to twenty inches in diameter. For convenience they are usually set on a 60-degree inclined framing, though the nearer vertical they are set the better they work. The length of the elevator is of course determined by the slope it is set on and the vertical lift made. The extreme lift now in operation is eighty-nine feet, though I do not consider that the limit of practical efficiency by any means. The lower end is slightly flared out, set in the bottom of the pit open, and with the



nozzle of the pipe, carrying water from the pressure box from two hundred to five hundred feet above, projecting into it, and in the line of the elevator. A short distance above the nozzle a throat section is set in, narrowing it from eleven inches to seven and one half to ten, dependent on the amount

of wear on the throat section, which, of course, can be replaced when worn too large. The upper end of the elevator is flared out a little, and discharges into a sluice box with riffles for saving gold. The action of this elevator is by the stream of water coming from the nozzle of the pipe and forced through the elevator by the head from the pressure box. This stream going through the throat section with its tremendous velocity creates a very strong suction, which lifts water, sand, gravel, and bowlders from the pit and discharges them into the sluice, where the gold is caught and the tailings discharged on the dump. For the proper action of the elevator, a large amount of water is necessary in the pit all the time. This water is first employed in ground sluicing, piping top gravel and waste off of the pay gravel, and in washing the latter in the pit in small boxes with a sluice head. Large bowlders are handled by the derrick or barrows, and piled in the pit on cleaned bedrock, and the fine material after screening by a grizzly goes into the elevator sump or pit, and is lifted out of the mine. Where the elevator discharges into the sluice the latter is covered by a heavy framing lined with green pine and liveoak logs, on which the water and gravel impinge before dropping into the sluice.

For pumping water, and sand and fine gravel if necessary, another form of elevator is designed and used. In this, the foot of the elevator, placed, if desirable, thirty feet above the sump, is a solid, pear-shaped casting, the nozzle screwing into the bottom and discharging through the throat at the upper end. The suction pipes from the sump enter the sides of this pear-shaped casting.

This class of machine is exceedingly efficient for pit mining. With it the problem of drainage is practically reversed, and the difficulty is not so much to get the water out of the pit as to get sufficient in to mine with. Quicksands and barren top dirt offer no serious obstacles to thorough mining, and the machine does the work of more men than could be practically worked on the same ground, and in a fraction of the time.

The Mammoth Bar Mine in Placer County has been successfully exploited by means of an open pit, working through elevators, after unsuccessful attempts for thirty years to mine the same ground by drifting, and it is to this mine more than any other that the credit of demonstrating the utility of these machines is due. Two views of the mine are given, illustrating better than verbal description the method of mining. The pit excavated in sixty feet depth of sand and gravel is now very large and has increased the facility of working. Instead of sweeping all the top dirt through the elevators to the dump, it is sluiced back on worked-out ground, and only the pay gravel washed into the sump, at a considerable economy of water and time. This mine uses four hundred inches of water under four hundred and fifty feet head for its elevators; but its experience has demonstrated that larger elevators and a larger supply of water would be still more economical, as the cobbles now moved by hand labor, slowly and expensively, could be then handled by the elevator rapidly and cheaply.

RIVER MINING.

Concerning the general proposition of river mining, it is subject to great uncertainty in the matter of ascertaining whether or not the particular ground it is proposed to exploit has ever been worked or not. Purely surface indications cannot be depended on, and the period of general activity in this branch of mining is now so long past that there is little or no reliable information possible from residents of the locality. But though the *river-beds* may have been worked over once years since, the tailings from

hydraulic and drift mines have replaced much of the gold that had been taken out. By means of elevators and large heads of water, it will prove profitable to work over these tailings in many of the larger rivers. Again, the winter flood waters are constantly working these tailings down stream and with them considerable amounts of fine gold. It would not, I think, prove unprofitable to put undercurrents in the rivers at points where they can be protected from washing out. The yield, of course, is not large, but neither is the expense connected with this kind of plant. Another method of work which is economical is the construction of a bedrock cut, paved with riffles, through which the great volume of the river and tailings are carried by the winter floods, the sluice being cleaned up in low water. This last described method of mining is rather more applicable to the smaller rivers and cañons where there is a high grade than to the large, wide rivers, but is sometimes of assistance in the latter in cleaning off the top ground of a pit.

SLATE QUARRYING.

A NEW BUSINESS DEVELOPING IN CALIFORNIA.

The essentials of the slate of commerce, such as is used for roofing, billiard beds, mantels, blackboards, tilings, urinals, caskets, grave covers, steps and risers, boxes, wainscoting, water tables, sills and lintels, trimmings for buildings, and many other purposes, are hardness and toughness.

When too soft the stone will absorb moisture, the nail holes of the roofing slate become enlarged, the slates loosen, and require replacement; also, if too brittle, the slate breaks under the weight of a man. When a hole is punched, no tenderness in the material or tendency to enlargement of the opening should be seen. Struck with the knuckles a good slate gives out a sharp, metallic ring. Color is not a reliable guide in estimating the durability of a slate. Black varieties are not in favor; the general impression is that they have not the necessary durability. Dark blue, bluish black, purple, gray, and green are the common colors; some of the purple slates carry spots of light green, which, by the way, do not injure their durability, but the grade is lowered by lack of uniformity in color.

In judging of the quality of a slate by the eye, a great deal of experience is required. The following tests are recommended:

First—Weigh the dry slate, then immerse it in water for twenty-four hours; take it out, wipe dry, and weigh again; the increase in weight will be the amount of water absorbed.

Second—Place the slate on its edge in water so that half the surface is covered; if it be of poor quality, moisture will creep by capillary attraction into that part of the slate above the water line, but it will not do so in a good slate.

Third—Breathe on the slate, and if a strongly marked argillaceous or clayey odor is detected, it is safe to assume the slate will disintegrate easily under atmospheric influences.

Dark veins running through the slate are objectionable, as they are liable to split along the line of the best resistance—nearly always found to be in the course of this vein or streak.

Crystals of iron pyrites should also be suspected (particularly when present as marcasite or white iron pyrite), which oxidize very quickly when exposed to moisture and the air.

The ordinary cubiform, brassy, yellow iron pyrites have much greater power of resistance to meteorological influences than the marcasite. They have been found in the atmosphere of Glasgow unaltered after an exposure of one hundred years.

A building in England was recently torn down, upon which slate had been laid, when it was first built, over one hundred and three years previous. The slates were found in good condition, and were relaid on a new edifice.

Practical experience has already developed the fact that slate will last upon a roof seventy-five years without any deterioration that can be noticed, either in appearance or quality.

ROOFING SLATES.

The slate most in demand for roofing and other purposes, mentioned at the outset of this article, is a clay-rock of great compactness and very fine grain.

Originally it was a deposition from water in which it was held in suspension; and, although deposited in layers, it has, under the influence of heat and compression, experienced marked changes, one of the results being that it will not divide along the planes of its bedding, but splits readily on what are called "the planes of slaty cleavage." This facile cleavage is the essential characteristic of good slate, as it enables the mass to be subdivided with thin sheets with perfectly smooth surface, and thus forms a comparatively light and impervious roof covering. It is of record that a piece of California slate, one inch in thickness, was split into more than thirty layers. The finest slates are found in the Welsh quarries.

EL DORADO SLATE.

The only quarries now being worked in the State are those of the California Slate Company in El Dorado County, at Chile Bar, two miles and a half from Placerville, on the county road leading from that place to Georgetown; the American River runs through one corner of the company's property. The first quarry employs sixty men at present, and the managers intend to double that number when the weather settles. Samples of this slate have been placed in the Mining Bureau, and experts, following the tests given in this article, pronounce it of good quality.

The slate deposit, so far as can be determined by surface indications and openings actually made, is a large one. These openings are near both the northern and southern boundaries, and also intermediate; in each, slate of good grade has been found. The layers of the deposit trend in a northerly and southerly direction, varying from a line due north and south by only a slight angle, and stand nearly perpendicular, with an inclination west. The qualities of the slate are said to be the desirable ones of tenacity, elasticity, moderate hardness, and perfect cleavage. Another quarry was opened on this property in May, 1889, from which roofing slate in considerable quantity is being taken. The new California Theater, recently built in San Francisco, is roofed with slates from these workings, and many contractors for new buildings in that city, as well as other cities in different parts of the State, have accepted the material for the same purpose. Slate quarrying is a comparatively new industry in California, but as the El Dorado article appears to be coming into general use, it is safe to predict that in course of time it will be an important one. An opinion recently expressed in regard to the enterprise is, in effect, that by enlarging the openings and equipping the workings with machinery, a thousand "square" of roofing slate per month can be produced and put on board cars at Placerville at a cost not exceeding $3 50 per square.

THE VALUE OF FOSSILS AS INDICATIONS OF IMPORTANT MINERAL PRODUCTS.

By Dr. J. G. Cooper.

In the "Catalogue of California Fossils," compiled in 1887–8, I referred to the connection between them and mineral products, as an important reason for recording all localities in which each formation occurs. There is no doubt that if more had been known of the different geological formations of this coast, and their productions, in the earlier years of mining, much useless and expensive work might have been prevented, where prospectors lost their all in vain search for minerals, which did not exist in paying quantities.

Dearly bought experience and scientific research have now shown us how far paleontology may serve to guide economical geology on this coast, and I propose herewith to give the results. On account of local peculiarities these do not always agree with such experience elsewhere, but they are no less valuable for workers on this coast. I do not attempt here to enumerate all the useful minerals, etc., of each formation, but only those known to exist in sufficient abundance to pay for working. It is evident that as there is no uniform thickness of any formation, older strata of different geological age may be found at any depth, while a later one is being worked. Therefore, the superficial occurrence of fossils of any one age is a guide to the mineral products only as far as surveys may prove that the formation extends downward. This usefulness may often be destroyed where volcanic or metamorphic changes have altered the lower strata, a very common occurrence on this coast. As nearly all elementary minerals must have been derived originally from the oldest rocks forming the earth's crust, and have been deposited in the stratified rocks containing fossils by aqueous and volcanic forces, they must exist in all of the formations to some extent, but only in certain ones in workable quantity or condition.

A. RECENT AND QUATERNARY STRATA.

It is as yet impossible to define the dividing line between these formations on this coast, since human remains are found at least as far back as the beginning of the quaternary, and nothing defining the end of the glacial epoch has been observed.

The superficial and rarely solidified formations are everywhere included in these strata, and the fossils they contain are chiefly of living species, the proportion of extinct forms determining the relative age of different beds. Since fossils of older formations are sometimes found scattered loosely in the more recent, though generally determinable as erratics, it is necessary to obtain numerous specimens to ascertain their perfect condition and true positions. This is especially true of those found in the much-disturbed gravels and lavas of the Sierra Nevada.

The mineral products of these strata are, first, those of placer and some hydraulic mines, viz.: gold, iridium, platinum, diamonds, sands for glass and mortar, clay; second, mineral or sea waters and contents: iodine, *bromine, potash*, soda, salt, magnesia, borax, alum, copperas.

The study of soils and agriculture is also founded chiefly on these superficial strata.

B. VOLCANIC PRODUCTS.

These, while partly formed by the action of igneous as well as aqueous forces, and containing minerals different from those of the usual stratified rocks, are on this coast so intimately mixed with the latter that they must be considered with them and often contain fossils of all ages more recent than the cretaceous. The action of hot water heated by volcanic dikes or the fires beneath, have also filled much of the older strata with mineral veins, and metamorphosed the rocks as late as the miocene almost beyond recognition in some places.

The only valuable minerals directly derived from volcanic outbursts are sulphur, basalt, lava, travertine, and other forms of building materials. Other igneous rocks will be mentioned among the archaean formations.

C. TERTIARY FORMATIONS.

The line of division between these and the quaternary is usually shown by more complete solidification, but is sometimes only definable by the greater proportion of extinct species of fossils, and is still quite undefined in some parts of California.

The mineral products in the Sierra Nevada are those of most hydraulic and drift mines, mentioned as quaternary also. In the Coast Range there are added the organic products:

Lignite, asphaltum, petroleum, infusorial sand, marl, phosphates, nitrates. Building sandstone is also of value.

The products called organic, all derived from animal or vegetable decomposition, show the important part played by the fossils which have formed so great a part of these later strata, which compose a very large proportion of our Coast Ranges. They also produce the most fertile soils, as compared with those derived from older rocks only.

D. CRETACEOUS FORMATION.

While there is still some uncertainty whether the eocene tertiary is not included in the division called "Cretaceous B," on account of the absence of a well defined line of separation, the fact is still established that all the fossils of that division are distinct from any living species. This itself forms a good line of separation, and may be proved to be more important than the old division between eocene and cretaceous. In this fossiliferous portion, or between divisions "A" and "B," is included the lignitic coal, of better quality than the tertiary lignite.

Large portions of the Coast Range, supposed to be of cretaceous age, have lost all traces of fossils and of stratification, but can be connected where they unite with the unaltered strata. These metamorphosed regions contain the most valuable mineral products of the range. Thus the infiltration of the stratified rocks, while destroying organic contents, has substituted veins of various minerals deposited from heated sea water, or of volcanic origin.

Alabaster, antimony, aragonite, cement rock, chromic iron, graphite, gypsum, limestone, magnesite, manganese, marble, mercury. Lithographic stone may be expected to occur in this or the following formation.

E. TRIASSIC AND JURASSIC STRATA.

On account of the scarcity of fossils so far found in these rocks, which are chiefly the Sierra Nevada slates, their exact limits have not yet been determined, and it is quite probable that they run together in California, on both slopes of that range. There is some reason to believe that these strata occur also in the Coast Range north of Lake County, and perhaps further south, but generally too much metamorphosed for identification. Their age being greater than that of the preceding strata, they are more metamorphosed and broken up by volcanic outbursts. The effect of this is shown by their containing more metallic elements, and they constitute the most valuable of all the California mining regions, producing gold, silver, copper, platinum, nickel, zinc; also, roofing slate and many building stones.

F. CARBONIFEROUS LIMESTONE.

The small exposure of this formation on the west slopes of the Sierra Nevada is identified only by its fossils. As it is found also in Nevada, chiefly as limestone or marble, containing good but thin beds of coal in the unaltered strata, this may also be expected to occur in southeastern California. In that part of this State there is much more limestone, probably of this age, containing silver-lead ore, with some gold, and other less valuable minerals. Being mostly metamorphosed and fossils rare, the value of this, and probably of some still older formations not yet identified in California, depends on the metalliferous veins, and chiefly the metals above named, not on the organic products, coal, etc., which are so important in the same formations in other parts of the world. They contain more or less of the same minerals found in all the later formations older than tertiary, but not usually so profitably worked as they can be nearer the coast.

G. ARCHAEAN ROCKS.

The crystalline and azoic rocks, sometimes partially stratified, constituting the lowest bedrock or crust of the earth, form much of the Sierra Nevada and portions of the Coast Ranges. They are distinguishable from the metamorphic and volcanic rocks by their mineral structure, and from the others by absence of fossils.

The valuable metallic veins contained in these rocks seem to have been formed in the same way as those in later metamorphic rocks.

Though containing a great variety, if not all, of the elementary minerals, these are usually so much diffused, or perhaps so deep down, as to be unprofitable for working, except the following to a limited extent: Gold, tin, iron, asbestus. Feldspar (kaolin), lithium, and titanium may also become of value.

Granite, gneiss, and porphyry are the most important building stones found in the archaean rocks, together with other products of ancient volcanic outbursts.

While the relation of valuable products to geological formations may be now considered as well established, as far as those here considered are concerned, many other minerals will doubtless be found to be valuable as the country becomes developed, and careful surveys are needed to show where these may be most profitably obtained.

CLAYS.

By W. D. JOHNSTON, M.D., Chemist State Mining Bureau.

Under this general term many varieties are included which are more or less used in the arts and manufactures. The characteristic property of clay, and one possessed by no other mineral substance, is that peculiar condition known as plastic. The ingredients of clays, to which this feature is due, is a hydrous silicate of alumina. When pure it is of a snow-white color; to the touch it has a soft, unctuous feeling, and is very easily broken; it adheres to the tongue, and gives off a singular smell when breathed upon, which has been designated the argillaceous odor. When moistened with water, a considerable quantity of the fluid is absorbed, and upon manipulation the clay speedily passes into the plastic condition, which enables it to be molded into many different forms.

The purest clay found in nature is known by the technical name of kaolin, or China clay, a word derived from Kauling, the name of a mountain in China, where this earth was first discovered. The Chinese are entitled to the credit of first utilizing kaolin in the manufacture of vessels for general domestic purposes. For many years the finer kinds of porcelain were imported from China, and the character of the materials used, as well as the method of manufacture, were kept secret until the advent of some Jesuit priests, sent there as missionaries. For over two centuries Europeans were thus baffled in their attempts to learn the secret of the materials used in the manufacture of Chinese porcelain. The information given by the cunning celestials was that the ware was manufactured from eggshells, seashells, and other matters which lay buried deep in the earth for a period of one hundred years. The ware naturally took its name from the country whence it was brought, and when a similar clay was discovered in other parts of the world, it was still called by the original name, kaolin, or China clay. The word "clay" is derived from the Anglo-Saxon Claeg; Dutch, Klei; German, Kleben, which means "to stick."

Dr. George A. Koenig, Professor of Geology in the University of Pennsylvania, who has made special microscopic investigations, states that kaolin is composed of minute particles, loosely aggregated, and invisible to the naked eye. Magnified eleven hundred diameters, these infinitesimal particles look like globules, and are not very unlike fish roe in appearance. Prior investigators had concluded that the kaolin material was crystalline, but Dr. Koenig, arguing from the lack of effect on polarized light, is satisfactorily convinced of the absence of anything resembling crystalline structure. He lays stress upon their similarity to globules of starch, as they are capable of absorbing water, of enlarging and passing into a plastic paste, the extreme mobility of which is easily accounted for by his assumption of the rounded form of the ultimate particles. Their extreme minuteness—less than the one ten thousandth part of an inch—enables this substance to remain suspended in water for a long time. River water, for days after a rainstorm has ceased, will have a peculiar milky opalescence due to the presence of these minute globules. The crystalline components of clay are generally designated as sand, and consist of fragments of different mineral species, such as quartz, feldspar, mica, hornblende, tourmaline, magnetic iron, etc. These crystalline substances may be found in particles not

much larger than the globules of kaolin proper, and thus remain suspended with it in water, while the coarser sand settles quickly, and may be separated from the kaolin and the finer crystalline materials. The contamination of the kaolin with these fine crystalline particles misled former observers and gave rise to the erroneous deduction that kaolin itself had a crystalline structure.

There are also compounds present in clays which often have an important bearing in determining their economic value. Among these are iron pyrites, sulphate of lime, carbonate of lime, dolomite, carbonaceous and bituminous matter, oxide of iron, etc. To these are due the various colors which characterize ordinary clays, and which vary in their effect upon the material when it is applied for technical purposes. In geological works clays are divided, in accordance with their occurrence, into primary and secondary deposits. From their physical conditions of structure and chemical composition, clays are technically separated into various classes, expressed by the words fat, long, lean, short, plastic, argyllites, clay-slates, marls, and loams.

For a proper understanding of the conditions expressed by these various words it will be necessary to consider the origin of clays. The primary rocks of which the earth is composed, and underlying all other rocks, are made up principally of three minerals—quartz, feldspar, and mica. Quartz is pure silica, exceedingly hard, and not acted upon by atmospheric or chemical agents at ordinary temperatures. Feldspar is composed of at least four elements—potassium, aluminum, silicon, and oxygen. These are in a state of chemical combination, and may be represented by the formula, $K_2Al_6Si_6O_{16}$. At times the potassium is replaced by sodium more or less completely, and in other cases the potassium may be replaced by calcium. The feldspathic material is nearly white, glassy in appearance, capable of cleavage, and but little softer than quartz. The third constituent, mica, is in composition made up of the same elements as feldspar, but contains, in addition, iron and magnesium. These three materials are the chief constituents of a number of primitive rocks. When, in forming a rock, they have a more or less parallel arrangement, it is termed gneiss, and the structure is called schistose or slaty. When these three constituents are more regular in their distribution through the rock mass, it is termed granite; and when feldspar predominates they form porphyry and trachyte.

In the variety of feldspar called albite, the potassium is replaced by sodium. The potash-feldspar (orthoclase), and the soda-feldspar (albite), are often seen together as constituents of granite, as in that of which Pompey's Pillar is made. Labradorite, a feldspar in which calcium and sodium have replaced the potassium, is a beautiful variety, of pearly luster, often exhibiting a play of blue, yellow, green, and red colors. There are other varieties, such as anorthite, in which calcium has entirely replaced the potassium, and oligoclase, in which both calcium and sodium are present, but the sodium predominates. The common feldspar is again subdivided into classes. Among these are adularia, the white or colorless subtransparent specimens, and sanadin, or glassy feldspar, which includes transparent vitreous crystals found in the trachytes and lavas.

The investigations of geological chemists have demonstrated that all the sedimentary rocks have been formed from a rearrangement of material derived in the first place from the disintegration of the feldspathic rocks, which must have been much more rapid at that period of our planet's life, when the water first found a lodging-place upon the heated earth, and when *the primitive* atmosphere was heavily charged with carbonic acid gas.

Observations upon feldspathic rocks show that under the action of the atmosphere the exposed surfaces become covered with a thin, soft, white, and opaque crust from this decomposition. This is particularly noticeable in those feldspars where the potassium has been replaced by calcium and sodium. In this change there is formed a soluble alkaline silicate, which, passing into solution, is probably in most cases decomposed by calcium and magnesium carbonates, giving rise to silicates of these bases, and to sodium carbonate. A gradual process of this kind is constantly going on in the feldspathic minerals which constitute so large a proportion of the sediments of many formations, and in strata deeply buried this decomposition is probably hastened by the elevation of temperature due to the internal heat of the earth. That carbonic acid gas is not necessarily an essential element of this decomposition has been proved by the experiments of Bunsen and Damour, who found that distilled water at temperatures below the boiling point of water would take up from feldspathic minerals comparatively large amounts of silica and alkalies.

From chemical and mechanical considerations it is evident that the major portion of the insoluble residue left after this decomposition of feldspathic rocks, cannot be pure kaolin, but must necessarily be a mechanical mixture of it, with more or less partly altered feldspar, and the most easily decomposed materials of the original rock, with a certain proportion of quartz. This material in the past has been deposited in the depressions on the earth's surface, and in changes due to the unstable condition of the earth's crust was subjected to heat and pressure and became consolidated, forming a true rock. This, in turn, was upheaved by the internal forces of the earth and was again subjected to disintegrating influences.

Among the materials forming clay are various minerals containing protoxide of iron; these, under atmospheric action, become altered to higher states of oxidation, and give to the clays all shades of color from the finest yellow to the deepest brown; they also explain why pure white kaolin is so seldom found. This disintegration of the primitive rocks and the rocks that were again formed from them, going on through millions of years, has resulted in a deposition in nature's settling-tanks of vast amounts of clay of more or less purity. They occur in beds of varying thickness, and follow the stratification in dips and strike of the underlying rock. These primary deposits of clay have been rearranged many times by subsequent geological changes, which have had effect in redepositions of these clays, and sometimes resulted in the purification of the clay mineral proper, and at other times in its degeneration.

The older clays have been compressed and hardened, and have formed slates. These primitive slates, when finely ground and placed in contact with water, will, after a time, become plastic clay. Between the hard slates of the older geological period and the softer slates of recent geological formations, we find a marked difference in texture and adaptability for technical purposes.

This power to pass, with water, into a dough-like plastic state decreases in proportion as a sandy element is mixed with the clay. It is strongest in the "fat" and weakest in the "lean" clays. A "fat" clay dries very slowly and unevenly, and the molded objects will warp and crack in drying. Aron found that the "linear shrinkage" does not correspond with the drying of the clay, as might be expected, but ceases when followed up to a certain point, which he designates as the "limit of shrinkage." The water evaporated up to this point, he terms the "water of shrinkage;" the remainder of the water lost, until the weight of the sample remains con-

stant at a temperature of 130 degrees C., he calls the "water of the pores;" the sum of both is total water.

If we assume that the minute particles of clay substance possess the round shape claimed by Dr. Koenig, this behavior is easily explained, as the "water of shrinkage" envelops these particles, and upon evaporation will allow them to approach, until each touches the other at six points on the surface. The intervals between all other points will still be filled with "water of the pores;" and its evaporation cannot produce any shrinkage of the clay. Now, Dr. Koenig claims that it is an important rule for the potter that the number and sizes of the pores are independent of the water contained in the clay, and is constant for all plastic clays; and, further, that the cubical shrinkage is equal to the volume of water lost by evaporation up to the limit of "linear shrinkage." Aron contends, further, that if the purest clay is mixed with fine quartz sand, the shrinkage will increase up to a certain point, which he terms the "point of greatest density." From this point the shrinkage decreases again, with increasing leanness, while the porousness increases. On submitting clay to a red heat, two molecules of water are driven off from the silicate of alumina at that temperature, and, as a result, the clay shrinks a second time. This is known as the "fire shrinkage," and can be neutralized by the addition of finely divided sand, and may even be made to produce a slight expansion. Finely pulverized chalk is also an excellent material to counteract the "fire shrinkage" in clays.

The proximate constituents of kaolin are alumina and silica. Pure alumina resists fusion at the highest temperature which can be obtained in the blast furnace. Quartz in the crystalline state, when exposed to the same temperature, has the terminal points of the crystals faintly rounded, and its surface becomes coated with a very thin glassy glaze; hence both substances are practically infusible. It is a general law in chemistry that the alloys of metals will have a lower fusing point than the arithmetical mean of the individual fusing points of the component metals. The chemical union of silica and alumina forms no exception to this rule—the compound glazing at the temperature at which wrought iron melts.

The experiments of Bischof and Richter show that the infusibility of the compound is increased with the percentage of alumina. To determine the effect of fluxing agents, Richter made the following experiment: The chemical union of one part alumina with two parts silica was obtained by subjecting the mixture to the highest heat of a blast furnace until partial fusion proved that chemical union had resulted. This product was finely pulverized and four equal portions of it were intimately mixed as follows: to one part was added 4 per cent of magnesia, to the second part, 4 per cent of lime, to the third, 4 per cent of sesquioxide of iron, and to the last, 4 per cent of potash. These four mixtures were made into small cylinders and exposed to the same heat of the blast furnace. The magnesian mixture had melted to a glassy slag, while the remaining three (lime, iron sesquioxide, and potash) had been only partially fused, so that he was justified in drawing the deduction that their fusing points correspond in ascending series to the molecular weights of these oxides: MgO,40 CaO,56 $\frac{1}{2}(Fe_2O_3)$, 80 K_2O,94. This result has been formulated by Richter into the following law: Equivalent quantities of different fluxing oxides produce the same effect upon the fusibility of a clay; for example, if analysis had shown that a certain clay contains magnesia three-tenths of one per cent and that another contains potash seven-tenths of one per cent, we could expect with certainty that both would have the same resisting power to the action of fire. *According to* the same observer the presence of these several substances in

the clay does not influence the effect produced by each singly, their fusibility increasing only with the higher sum of their combining weights. As one of the most important uses of clays to the manufacturer is their power to resist high temperatures, the significance of the deduction from this experiment is obvious.

FIRE-BRICK.

As the name indicates, the requisite property in a fire-brick is its capability of resisting high temperatures. In composition, these bricks consist of a very nearly pure clay, or of a mixture of pure clay with clean sand; rarer kinds are met with which are composed of nearly pure silica, bound together by a small proportion of clay. Objectionable ingredients are oxides of iron, if the percentage exceeds 6 per cent; and magnesia, lime, soda, or potash, when their combined weight exceeds 3 per cent.

The fire-bricks most infusible are made from the Welsh Dinas clay, which contains 97 per cent silica and 3 per cent other constituents (alumina, 1.39; ferrous oxide, 0.48; lime, .019; potash and soda, 0.20; water, 0.50.)

In constructing lead smelting furnaces, experience has demonstrated that fire-bricks made from clay (kaolin) united with clean sand are preferable.

In the manufacture of retorts for gas works, the melting pots of the glass factories, the muffles and crucibles of the assayer, fire-clay must be of excellent quality; and great care has to be exercised in molding, and particularly in baking.

Fire-clays are usually found in the coal measures just beneath the seams of coal.

A good quality of fire-clay was discovered in the Black Diamond Coal Mine, from which, years ago, large quantities of fire-brick, crucibles, and stoneware were made by the Albion Pottery at Antioch.

An exceptionally good quality of fire-clay, from Carbondale, Amador County, has been analyzed this year in the laboratory of the Mining Bureau. The analysis is No. 8 of the California series, given under "kaolin."

The "alum-bearing" clays contain aluminum sulphate, which, when combined with potassium sulphate, forms the useful salt, alum. In these alum clays the sulphuric acid has been derived from the oxidation of the sulphur in iron pyrites, the iron being left in an oxidized state and the sulphuric acid united with the alumina. Alum, in the common use of the word, is the sulphate of alumina, and potash, and water of crystallization: Aluminum sulphate, 36.2; potassium sulphate, 18.3; water, 45.5. If the potassium sulphate is deficient, it is made up by the addition to the leachings from the burnt alum shales. When found in nature, it forms the mineral called kalinite; when ammonia replaces the potash salt, the mineral is tschermigite. These minerals and the native soda alum (mendozite) have a marked resemblance, both in taste and appearance. Alum has been found in incrustation ten miles north of Santa Rosa (4,468), and near Newhall, Los Angeles County (4,404). Alum slate occurs near Auburn, Placer County (4,249), and the exhibit in the Mining Bureau Museum (4,250) is alum crystallized from it. Alum, in thick incrustations, is found at the Sulphur Bank Quicksilver Mine, Lake County, in considerable quantities (1,108), and has been reported as occurring at Silver Mountain, Alpine County; Howell Mountain, Napa County, and at numerous localities in the State, as a slight incrustation on the rocks.

The ordinary yellow brick clays contain iron in the state of oxide and carbonate chemically combined with water, forming what are known in chemistry as hydrates. The expulsion of this water in the process of

burning imparts a red color, due to the conversion of the hydrated oxides of iron into the anhydrous form. The principal constituent in brick clay, and that upon which its plasticity depends, is the chemical combination of silica and alumina, more particularly described under the head of "Kaolin." This constituent used alone shrinks and cracks in drying, warps and becomes very hard when baked. Silica is also present in nearly all clays in an uncombined state, such as sand. A proper proportion of sand prevents cracking, shrinkage, and warping, and furnishes silica necessary for a partial fusion of the materials which increase the strength of the brick. The sand also makes the brick more shapely and equable in texture; but an excess of sand in clay renders the brick made from it too brittle. A small quantity of carbonate of lime has a beneficial effect upon brick clay in two ways—it lessens the contraction of the newly-made bricks in drying, and acts as a flux in the kiln by the formation of silicate of lime, which binds the particles together. It is evident from this that an excess of carbonate of lime in the clay would cause the brick to melt and lose its shape. Iron pyrites in a brick clay are objectionable; also the presence of carbonaceous matter to any considerable extent, as a black discoloration, similar to that produced in bricks in proximity to chimney flues, is likely to occur.

Common salt is nearly always present in minute quantities in clay. In that near the seashore the amount is apt to be so great that bricks made from it are certain to be of a poor quality. Salt melts readily and glazes the outside of the bricks, and the heat cannot be raised or maintained sufficiently long to burn them to the core, or into good, hard brick; as a consequence, they are soft and, from the presence of the decomposed salts of magnesia and soda, are always damp, owing to the tendency of these salts to absorb moisture from the atmosphere. The presence of the alkaline carbonates in clay to any notable extent, prevents its being used as a brick clay, the alkali causing the material to melt readily.

Brickmakers divide clays into three classes:

First—Plastic or strong clays, which are chiefly a silicate of alumina; these are called by the workmen "foul clays;" a more fitting name, and one by which they are also called, is "pure clay."

Second—Loams or mild clays are those in which there is a considerable proportion of sand intermixed.

Third—Marls or calcareous clays are, as their name indicates, clays containing a notable quantity of carbonate of lime.

"Malm" is a name applied to an artificial marl, made by adding to and intermixing with the clay a proper proportion of carbonate of lime.

As a general rule, a clay fit for the manufacture of a first class quality of brick is not met with in nature. There is most always a deficiency of sand or lime. A good brick clay is one that contains sufficient fusible elements to bind the mass together, but not so much as to make the bricks adhere to each other or become vitrified. Such clays contain from 20 to 30 per cent alumina, and 50 to 60 per cent silica, the remainder consisting principally of carbonates of lime and magnesia and oxide of iron.

Pure or "foul clays" are sometimes used for bricks without any admixture of substances to improve the material. Bricks thus made are generally deficient in weathering qualities. The color of bricks depends upon the composition of the clay, the character of the added ingredients, the temperature at which they are burnt, and the amount of air admitted to the kiln. A clay free from iron will burn white, but, as a general rule, carbonate of lime (in the form of chalk) is added to produce white bricks. The presence of iron oxides produces a tint which varies from light yellow

to dark red, the intensity of color increasing with the greater quantity of the oxide. If 8 or 10 per cent of iron oxide is present, and the brick becomes intensely heated, the red oxide of iron combines with the silica and fuses, producing a dark blue or purple color. The presence also of a small quantity of oxide of manganese, in addition to the oxide of iron, will cause a material darkening of the red tint. By the presence of small quantities of lime the red color of iron oxide is modified to a cream tint, while larger quantities make a brown color. Magnesia also changes the red tint to yellow.

For general purposes bricks may be divided into three classes. First class, building brick. These should be free from cracks and flaws, and devoid of lumps of any kind. They should be hard, and so thoroughly burnt that incipient fusion has taken place all through the brick. This may be determined by scratching a fractured surface. A knife will hardly make an impression unless the brick is underburnt. A brick thoroughly burnt and free from cracks will give a clear, ringing sound when struck.

Brick of fair quality will bear a compressive force of three thousand pounds to the square inch. Very soft brick will yield at as low a pressure as three hundred and seventy-five pounds, while the best quality of pressed brick will withstand a compressive force of six thousand pounds. Masses of brickwork crush under smaller loads than do single bricks, and good authorities claim that first quality brick laid in the best cement should not be subjected to more than one hundred and forty pounds to the square inch as a permanent load.

Second, cutters or rubbers, which are purposely made soft to be readily cut with the trowel, and then rubbed to a smooth face and the required shape. Of necessity, bricks of this character are of too soft a nature to be used where there is much exposure to the weather.

Third, underburnt or misshapen bricks, known to the trade as "grizzle" or "place" bricks, and also termed "samel" bricks. These are always soft inside and very frequently soft on the outside also. They are liable to decay, and are unfit for good work.

The character of bricks made and used in early days in San Francisco is strikingly exemplified at the present time, in the ricketty condition of the old City Hall and various buildings, the inferior materials of which have necessitated their demolition. The absence of hard frosts in that city and neighborhood has been a very important factor in disguising the faulty constitution of our pioneer bricks.

POTTERY.

The word "pottery" is supposed to be derived from "poterion," the drinking cup of the Greeks, and to have been transmitted by the French word "poterie." The term is applied to all objects of baked clay.

One of the earliest manifestations of the dawn of intelligence among our remote ancestors was in the construction of rude cups and vases from clay. Possibly the first indication of its plastic nature was noticed by the impression of their bare feet where the clay had been softened by rain, and these pieces retaining the impression were accidentally or purposely subjected to the action of fire and found to retain their shape, change their color, and this likely gave rise to the idea that this material could be utilized in the manufacture of vessels to hold solids or liquids. The savage tribes of the present day make, with their rough appliances, articles of pottery which have the same general form and fashion of those made by the most ancient race who have left us fragmentary traces of

their crude clay vessels. The potter's art manifestly had its origin in the wants and necessities of man's common nature, which, being the same in all countries, led up to similar inventions.

The art of pottery orginated spontaneously and independently among many different races. Similarities in forms, and even in the manner of ornamentation, are noticed in these primitive emanations from the potter's hand. The points of resemblance seen in comparing the forms found in the old world with those found in the new do not prove the identity of the origin of the different races, but they show that the workings of the human brain in widely scattered nations lead to similar and almost identical forms of work. Much light has been shed upon ancient history by the fragments of pottery and tablets of baked clay exhumed from the earth. In the manufacture of pottery, and in its varied uses, history indeed seems to repeats itself; for in our day we find it, as in the earliest centuries, occupying a prominent place for domestic and ornamental purposes, as well as architectural, irrigation, drainage, and sanitary uses.

As a fire preventive and fire-proof material, there is nothing yet discovered that will take the place of pottery. Indestructible, and resisting alike the wear and tear of the elements and the ravages of time itself (a virtue as well known to the ancients as to ourselves), it has been the means of aiding historical research, clearly defining the domestic manners, and contributing greatly to the disentanglement of the history of nations long since passed away, and which would have been forgotten but for the everlasting evidence furnished by the potter's art. The extent of the Grecian empire in its palmy days can be traced by the Grecian funeral pottery, which long survived the political existence of the Grecian empire. In like manner the extent of the conquest of the Roman Legions can be deduced from similar forms of Roman pottery. A large portion of what we know of Assyrian history has been derived from the broken clay tablets discovered in Assyria. In ancient Egypt, in the catacombs of Thebes, which are known to be over four thousand years old, a series of drawings have been discovered impressed upon clay, which exhibit the potter's art as practiced at that time, and by which it is proved that the clay was kneaded with the feet, shaped on the potter's wheel, and baked in the oven. In sacred writ we find the expression, "And the Lord said, 'O, house of Israel, cannot I do with you as with this potter? Behold, as the clay is in the potter's hand, so are ye in mine.'" In the stone age remains of pottery, primitive and rude, have been discovered. Most of the urns of this period, in which have been found the ashes of the dead, were made of sun-baked pottery. In the bronze age the remains of the pottery found show that the potter's wheel had been used in its manufacture.

According to Mariette, the Egyptians had glazed pottery, on which the glazing was colored a light blue, as far back as three thousand seven hundred years before Christ. Vessels, urns, armlets, finger rings, and sepulchral figures were made of this glazed clay. Specimens of these various objects are on exhibition in the museum of the Mining Bureau.

Kiln-baked bricks occur only in the ruins of ancient Babylon, and were pressed out of a wooden mold. Some have been found bearing the name and title of Nebuchadnezzar. In the ruins of Babylon it is claimed that original Chaldaic accounts of the genesis and of the deluge have been discovered stamped in cuneiform characters on clay tablets.

The oldest fine pottery made by the Greeks cannot be more recent than the seventh century B. C. Greek pottery has been divided into five classes, corresponding to the stages of the rise, progress, maturity, decline,

and decay of the country, and they have been designated as the Egyptian, Archaic, the Beautiful, the Florid, and the period of Decadence.

The Egyptian is so called because the knowledge of the art was obtained from Egypt, and the early forms of ornamentation on the vases were characteristically Egyptian, being those of winged birds and animals.

The Archaic varieties, of human figures, many of them of exceedingly handsome designs; the Beautiful, as the name implies, were still finer works of art, in which finely formed human figures, male and female, were most often the subjects. The Florid, which dates about the third century B. C., is characterized by the vases being much larger in size and very beautifully adorned with human figures, flowers, fruits, and fancy patterns. In the clays and pottery made by the Greek during the second century B. C., and designated as the Decadence, marked inferiority in the beauty of the patterns, the clay material, and style of finish is very noticeable. Vessels of pottery for domestic purposes were in extensive use by the Romans. What is now known as terra cotta was utilized as the bas-relief for interior decorations of their houses; mortuary urns of baked clay held the ashes of the dead. Pliny speaks of the pottery made at Aretium, the modern Arezzo, a city of Tuscany, as being of a superior kind. It is bright red, of the color of sealing wax, and coated with an alkaline silicate glaze. The prevalent form of the work is that of a teacup without handles.

Pottery belonging to the Anglo-Saxon period occurs extensively in England; the specimens were apparently modeled by hand, made of a clay rather coarse in texture, and often not baked. The ornamentations consist of parallel, and sometimes vertical and zigzag lines; on some pieces the spaces are found filled up with small circles and crosses stamped or painted in white. The characteristic peculiarity of the Anglo-Saxon burial urns consists in raised knobs arranged in a symmetrical manner around the upper portion.

In Germany, urns made of a paste of clay and sand, intermixed with white, yellow, and brown mica, have been found along with remains of the Teutonic races. The vessels unearthed in central Germany are more ornamental than those in the north, but the ornamentation was crude, consisting of lines, zigzags, network, semi-circles, and diagonals.

During the darkness of the middle ages that followed the decline of the Roman Empire, the art of manufacturing decorative pottery was entirely lost in Europe. We find it first reappearing in Spain, brought there by the Saracens, who particularly excelled in the manufacture of beautiful tiles, called by the Spaniards "azulejos." These were made of a pale clay, the surface coated over with a white opaque enamel, upon which elaborate designs were executed in colors. The courts of the Moorish palace of the Alhambra were paved with these tiles; but only a portion of one pavement is now left.

From Spain the art of decorative pottery was transmitted to Italy, and the initial attempts there to make glazed earthenware are plainly imitations of Moorish pottery. The first improvement, due to the Italians, was an opaque glazing composed of an oxide of tin, which may be considered as the starting point of majolica ware. Lucca della Robbia, born in 1400, was the artisan who made this discovery. He found that if his figures in clay were brushed over with a glaze of tin oxide, combined with colored substances, an extreme durability was secured. His pottery was exceedingly artistic. The frame work of his compositions generally consisted of a row of small heads, angels or cupids, or wreaths of flowers and fruits. Decorations for church altars, medallions, and bas-reliefs were also manufactured by him.

The taste for decorative ware of the majolica variety quickly spread to other countries, particularly to France, and was there called "Palissy" ware, named after the celebrated Bernard Palissy, who, starting life in poverty and in the face of many difficulties, acquired a taste for experimental chemistry, and taught himself painting by copying the works of the great masters. He became an enthusiastic admirer of the Italian ware, and determined to devote himself to the problem of discovering the composition of their various enamels. For sixteen years he pursued his investigations, being at times in the most dire distress. To provide fuel for his furnace he was compelled to burn up the greater part of his furniture, and even a portion of the flooring of his house. Success at last crowned his efforts, and a few of his first works, adorned with figures of animals and so colored as to imitate nature, sold for such high prices that he was enabled to complete his investigations, and at the same time lay the foundation of his future fortune. The ware made by him was generally ornamented with fishes, frogs, lizards, and plants, such as are found in the neighborhood of Paris. Palissy ware has no preceptible mark, but on many of the pieces with scalloped borders there is a daisy (which in French is "marguerite") as the particular ornament, probably placed there to show Palissy's affection for Marguerite of Navarre.

Holland early became celebrated for its pottery. The principal manufactory was at Delft, hence the product was called "Delft" ware. This was coated with a glazing of oxide of tin; the ornaments were chiefly in blue, and the ware was remarkably light and very hard. In shape it resembled that made in China and Japan, and was sold chiefly to the English. It was passed off on them as being really the article manufactured in China and Japan, but in fact the articles were only excellent imitations.

Germany has long been celebrated for its skill in pottery, the first manufactories being located at Cologne, Coblentz, and other places on the Rhine. One of their products consisted of brown-stone pots known as grey-beards, with the bearded mask on the neck; they also made stoneware jugs ornamented with subjects taken from the Scripture and the various coats-of-arms of the electors and princes of Germany. The drinking mugs were adorned with quaint patterns, around which were inscribed mottoes suggestive of banquets, love, and affection.

The earliest known potteries in England date back to one established at Lambeth in 1640, and one at Fulham shortly afterwards. The Lambeth pottery very soon took up the manufacture of delft ware, making tiles with scenery and houses depicted on the surface in blue. In 1720, the discovery of the use of pounded flint as a constituent of earthernware was the starting point of great improvements in its manufacture. The flint was mixed with sand and white clay and colored with oxide of manganese and copper, forming the products called "agate ware" and "tortoiseshell ware." Glazing with salt was discovered about 1680. White and cream-colored ware glazed with salt was extensively manufactured after 1690, and some of the product was of such fine quality as to almost resemble a porcelain. Wedgwood, in 1773, after numerous experiments, succeeded in making the ware which has since passed by his name. He used sulphate and carbonate of baryta in combination with finely-ground flint and potter's clay, and thus obtained a dense compact paste exceedingly plastic and sufficiently hard after baking to receive a good polish.

The most valuable pieces of Wedgwood ware are the copies of the famous Portland vase, the original of which is in the British Museum. They are composed of two layers of vitrified material, one white and the other blue.

The original price of each copy was $250; but now, of course, as copies have grown scarcer, prices have been exceedingly enhanced.

California is peculiarly favored as a center for the manufacture of articles of clay now in use, and the rapidly growing popularity of this class of material, especially for building purposes, is evidenced by the increased output of the numerous potteries throughout the State. By reason of the equableness of our climate, and the length of the summers, work can be carried on to great advantage throughout the year. The exports of manufactured articles have been steadily augmenting, and the increase of our population causes an enlarged domestic consumption. Shipments to Washington, Oregon, Nevada, Mexico, and Texas are of regular occurrence, and so progressive and flourishing appears the industry in all respects that additional capital is being enlisted, and it is destined in the not very remote future to contribute in a most substantial manner to the wealth of the State.

The capital already invested amounts to upwards of $1,000,000, and employment is furnished for many hundreds of people, principally whites, at lucrative wages of from $2 to $6 per day.

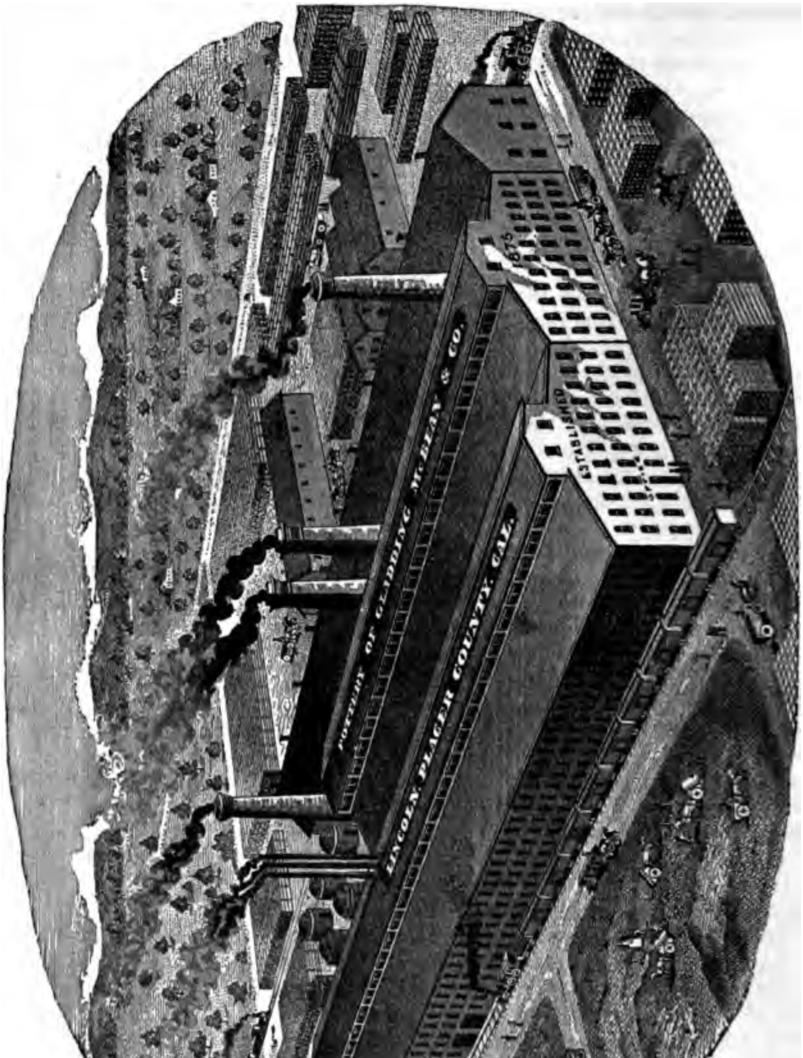
Adjacent to railroad communication in various parts of the State, practically inexhaustible beds of clay are found. Lincoln, Placer County, on the Oregon Division of the Central Pacific Railroad; Carbondale, Amador County; Elsinore, San Diego County; Los Angeles, Sacramento, and San Francisco Counties, have all deposits of this material. In the county last named the clay found is of a coarse quality, but when mixed with the better grade shipped from Carbondale, is used in the manufacture of articles of a cheaper and more common character.

Clay beds are also found in various places in the Counties of San Bernardino, Monterey, Inyo, Calaveras, Alameda, Contra Costa, Tehama, Humboldt, Napa, and Sonoma, California, but are generally of the coarser qualities.

There are also to be found in California, in several localities, clays from which a good grade of crockery ware could be readily manufactured, but although once experimented upon in a small way, the enterprise was abandoned, as competition with the eastern and imported goods of this character could not be profitably maintained. The same state of affairs may, in a measure, be said of fire-bricks. While it is an admitted fact that as good a quality can be and is manufactured here, as the imported or English article, still a restrictive influence is laid upon extensive production by reason of heavy importations at so low a rate as to cut off, in a great measure, reasonable profit for the local producer.

The most extensive establishment engaged in the pottery business in California, and doubtless west of the Rocky Mountains, is that of Gladding, McBean & Co., whose factory is located at Lincoln, Placer County, on the line of the Oregon Division of the Central Pacific Railroad, with their principal office and depot in San Francisco. Starting in business in 1875, their works have, from time to time, been enlarged, and buildings of two hundred and twenty-five by four hundred feet, constructed of brick and iron, are now in use. Three large boilers and engines of one hundred and fifty horse power, of the latest and most approved patterns, furnish motive power. In addition there are six large clay mills, two steam presses, elevators, etc., and all details appertaining to a pottery factory plant of the most complete character. About one thousand five hundred feet of side tracking have also been constructed. At the outset, their attention was devoted exclusively to the manufacture of sewer pipe, but gradually branching out, as the necessities of the demand warranted, they now produce a great

variety of articles, chief among which may be mentioned terra cotta, for architectural and ornamental purposes, piping, fire roofing, tile, fire-brick, building brick, etc. Their unusually fine work in terra cotta, and the



great variety of their designs, would seem to merit special attention, as nowhere in the United States are they surpassed. Among the specimens of *terra cotta* work turned out from this establishment for the Society of

Pioneers' building, San Francisco, is a very artistically executed medallion of General John A. Sutter, who arrived in San Francisco (then Yerba Buena), in the month of June, 1839. Afterwards built the famous fort at Sacramento, and in 1848-49 made himself so serviceable to the overland immigration of that time.

GENERAL SUTTER.

A very handsome sample of terra cotta ornamental work is in place at the State Mining Bureau, as are also samples of clays, which have been analyzed and are used in the manufacture of pottery wares and fire-bricks.

A very excellent panel, representing that immigration, and called "Pioneers crossing the plains," is in the same collection. The panel is in three partitions, and, as will be seen by the copy given on the following page, represents the hardships experienced by the immigrants en route, and the joy shown when the promised land first broke upon their view.

Some two hundred employés (white labor exclusively) find steady employment the year round at remunerative wages. The output of their manufactory finds its way in large quantities to every coast State, and as far south as Texas. The architectural terra cotta used in the new "Chronicle" building, also the fire-proof tiling, is of this firm's manufacture; so also are the terra cotta ornaments in the Pioneer Hall, New California Hotel and Theater, the cathedral on Van Ness Avenue and O'Farrell Street, W. H. Crocker's residence, California and Jones Streets, and very many other of the costliest structures in San Francisco, as well as the principal buildings of the leading cities and towns of the coast.

Another episode of the early history of California, perpetuated by the artistic terra cotta work of Gladding, McBean & Co.'s establishment, is the raising of the bear flag at Sonoma on June 14, 1846, when the country was declared independent by a small party of ambitious adventurers; the flag bore the words "California Republic."

Introduced for the first time on this coast by the above named firm, are what is known as the "Roman Brick," made of fire-clay and burned to a

PIONEERS CROSSING THE PLAINS.

RAISING THE BEAR FLAG

dark straw color. They are twelve inches long and four inches wide, an inch and a half thick, and are exceedingly strong as well as fire-proof. This variety of brick is largely used in the principal eastern cities, and its introduction to popular use here would seem to be but a question of time.

There are quite a number of potteries in various portions of the State, chief among which may be mentioned that of N. Clark & Sons, of Alameda County, with principal office and depot in San Francisco. They began business in Sacramento in 1864, but their plant being destroyed by fire, removed to Alameda County. They employ fifty hands, white men exclusively, and their works are kept running the year round. Sewer-

pipe and fire-brick are the principal articles of manufacture. Their clay is shipped almost exclusively from Carbondale, Amador County.

Serril Winsor, with a well equipped factory at East Oakland, Alameda County, employs forty men during the greater part of the year, work being stopped some two or three months during the winter time, generally from about the middle of November to the first of February. Their clays are likewise obtained principally from Carbondale, Amador County, at an estimated cost of about $3 50 per ton laid down at the factory. The principal articles manufactured are sewer pipe, chimney and flue pipes, and flower-pots. The main depot and office are in San Francisco.

In addition to what may be called the terra cotta illustrations of California's early history—made in this State, and now in the Pioneers' collection—is the medallion of an ideal head of Liberty. The subject is treated

LIBERTY.

with a great deal of freedom by the designer, and the face is splendid in the reposeful majesty of power. But it is also interesting to minds of a practical character to notice how well adapted is the material used to give sharp and perfect expression to the fine as well as broad lines of the design.

At Los Angeles the California Sewer Pipe Company is quite extensively engaged in the business its name indicates; at Riverside, the Pacific Clay Manufacturing Company; at Elsinore, the Southern Coal and Clay Company; at Sacramento, George Muddox; at San José, A. Steiger & Sons, and Tracy Bros. & Co., of San Francisco, are all engaged in the manufacture of various articles in clays for structural, ornamental, and other uses.

California contains within her borders deposits of those clays which, by proper washing, yield kaolin. Some of those which have been examined by the State Mining Bureau compare favorably with the foreign clays from which the noted porcelains are produced.

FOREIGN KAOLINS.

	China.	St. Yrieux.	Aue.	Cornwall.	Mori.
Silica	50.63	48.37	46.00	45.82	71.42
Alumina	32.74	34.95	39.00	38.60	26.07
Iron oxide	2.64	1.26	.25	----------	1.93
Lime	.50	----------	----------	3.47	.13
Magnesia	.27	----------	----------	----------	----------
Alkalies	2.52	2.40	----------	1.77	.45
Water	10.01	12.62	12.74	9.08	----------

AMERICAN KAOLINS.

	Indiana.	New Jersey.		Wisconsin.		
Silica	40.50	45.61	38.20	49.94	69.34	58.47
Alumina	36.35	39.04	35.09	36.80	19.19	28.87
Iron peroxide	.15	1.10	1.82	.72	1.75	1.54
Lime	----------	----------	----------	----------	.44	1.62
Magnesia	.13	----------	.21	----------	.31	.99
Alkalies	.14	2.51	2.65	.92	5.73	2.64
Water	22.60	10.90	12.10	11.62	2.67	9.48

Examinations were made of twenty clays which, to the eye alone, gave promise of merit, of which number fifteen were finally taken for analysis, eleven of which are of a character worthy of being reported upon, the others being worthless for pottery.

CALIFORNIA.

	1	2	3	4	5	6	7	8	9	10	11
Silica	85.07	88.70	59.98	57.02	57.75	47.33	49.08	48.90	12.54	66.75	88.30
Alumina	7.85	4.50	30.29	31.06	30.60	38.00	37.09	38.18	42.97	37.35	.85
Iron peroxide	1.16	.50	.27	.53	.48	1.08	1.91	2.40	.63	.25	.15
Lime	.25	.93	.28	------	.20	.67	.53	.50	------	.20	1.03
Magnesia	.35	.36	------	------	.10	.42	------	.09	------	------	.48
Alkalies	.93	.63	1.02	2.32	1.30	.71	------	1.85	4.70	4.32	5.07
Water	4.35	4.46	8.05	8.95	10.15	11.65	10.60	8.65	38.40	50.25	4.40

Clays one and two were separated from the coarse sands, that which was analyzed passed through a one hundred-mesh screen. Clays three to eleven were separated from all sandy impurities by washing.

Clay No. 1 is from near Jolon, Monterey County; it is white with a tinge of yellow; when moist has a yellowish-brown color, semi-plastic; suitable for the production of the finest grades of terra cotta.

No. 2 is a sandy clay from Chico, Butte County; white, with brownish tinge; when moist has a light-brown color; it also is suitable for terra cotta work.

No. 3 is a fine white clay from Amador County, very plastic; suitable to *make* finest grades of porcelain. This clay contains 73.63 per cent of pure

kaolin; 24.37 per cent of the silica is partially in the hydrated state, and combined with the other bases.

No. 4 is from Carbondale, Amador County; it is white and plastic, could be used for porcelain; contains 76.2 per cent of pure kaolin; 20.83 of silica is in the hydrated state.

No. 5 is from near Grass Valley, Nevada County, on Section 3, Township 15 north, Range 9 east. It is a fine clay, suitable for fine ware, white and plastic; can be made highly so by working. It contains about the same percentage as No. 4.

No. 6 is also from Grass Valley, Nevada County, on Sections 4 and 5, Township 16 north, Range 8 east. This is a fine white clay, suitable for any purpose, being plastic and soft; it contains 94 per cent of pure kaolin; 3 per cent of silica is combined with the bases.

No. 7 is a fire-clay from the Clipper Coal Mine, near Lincoln, Placer County; it is nearly a pure kaolin, soft and unctuous; would hold a large percentage of siliceous material.

No. 8, a fire-clay from Carbondale, Amador County; this is also nearly a pure kaolin; the original sample held 70 per cent of coarse siliceous material.

No. 9, a clay from near Daggett, San Bernardino County; it is soft, white, and very plastic, contains a large percentage of alumina. The chemical composition of a pure kaolin is $Al_2O_3 2SiO_2 + 2H_2O$, but that of the above gives the following: $2Al_2O_3SiO_2 + 10H_2O$. Theory would show that it is pure kaolin combined with aluminum hydroxide, and would be represented by the fomula: $(Ai_2O_3 2SiO_2 2H_2O) + 3(Al_2O_3 6H_2O)$.

In producing porcelain from this clay, a large per cent of silica would be required, also additions of lime. In experiments conducted at San Diego porcelain of good character was made from clay beds found near Daggett.

No. 10 is an aluminous clayey body from the sulphur banks in Lake County. It is soluble in sulphuric acid, the silica readily separating out; it could be cheaply manufactured into alum. This clay is well adapted, judged from our original sample, for use in sizing paper.

No. 11 is from Carville, Trinity County; is not strictly a clay, though white, soft, and somewhat plastic; under intense ignition it slightly agglutinates, and after cooling feels sandy; it resembles more nearly in character the Japanese clays exhibited in the International Exhibition of 1876.

In conversation with parties who apply to the Mining Bureau for information in regard to kaolin we find that they have, as a general rule, an idea that kaolin to be valuable must be found in a state of comparative purity. This is an error that we deem of sufficient importance to correct in this report.

The clay from the most noted deposits in Delaware County, Pennsylvania, is not, as taken from the pit, fit for the potters' use, and it is necessary to separate the pure clay from deleterious ingredients. The amount of contamination usually found may be inferred from the statement of H. A. Johns, of the National Kaolin pit: that to produce twenty thousand tons of washed clay about sixty thousand tons of crude clay have been removed from the pit, and that there has probably been handled five hundred thousand tons of material, including the crude clay. A brief description of the method employed may serve as a guide in future works of the kind in this State.

The crude clay is separated, by careful digging and handling, from a large mass of sand with which it may be associated; it is then hauled to the mill and placed on the stock pile, from whence it is taken and dumped into the mixing trough, in which the clay is thoroughly broken up and mixed with water.

The clay and sand mixed with water runs into a trough, in which a vertical wheel revolves with pocket elevators on its circumference. The sand in this trough settles to the bottom, and is carried off by the pocket elevators.

The water holding the clay in suspension then passes into board sluices known as "clay runs" or "slips." These slips are placed side by side, and the clay in going through them is carried over a distance of between six hundred and nine hundred feet. As the clay passes through these sluices the sand falls to the bottom, and is ultimately removed from the troughs.

The final discharge is into large settling vats, where the pure clay, in the course of a day or two, settles; the clear water is then drawn off from the tops. From these vats the clay is pumped, under pressure of about one hundred and sixty pounds, into canvas bags, and placed in hydraulic presses, where the excess of water is removed. The clay, after removal from the press, is placed on shelves in the open air to dry. In this state it is sold to the manufacturers of fine chinaware and porcelain.

The final methods of preparing clays and other ingredients requisite in the production of porcelain differ in each country and in different works. Nationalities have methods peculiarly their own, and each manufacturer endeavors to retain as his own the secrets of his particular compositions and methods of combination.

The following can be assumed to be the general method followed throughout the various countries:

Clays brought from the beds are allowed to "slack" in the air and disintegrate; different clays requiring more or less time, according to the nature of their constituents and the season of the year; after the aging has occurred the clays are washed.

The clays are "dissolved" in water; that is, pure clays, being of light gravity, suspend readily, while "undissolved" clays, sands, and coarser particles sink in the water.

The impure clays are placed in circular tanks or vats, four by six feet in diameter, in the center of which is a revolving perpendicular shaft with arms radiating and so arranged as to thoroughly cut up and incorporate the clay and water; when the mixture is equally and thoroughly combined and has attained the thickness of cream, the floating clay is drawn from the mixing vat into the sifting apparatus, which are inclined screens agitated by cams, the first two of the series being of a coarse and fine wire, the other of silk bolting cloth, arranged so that the clay which passes through the wires is carried to the higher end of the silk cloth.

The clay which has passed through the silk bolting cloth runs into the bottom of a second circular vat, which has revolving arms that rotate slowly; the overflow from this tank is run through long "launders" or sluices to the settling tanks; the clay, after passing through the silk screens, still contains a small percentage of minute sands and micas, which separate by their own gravity in the "launders."

From the "launders" the purified clay is run into circular vats, allowed to settle, the clear water run off (if necessary, it is here treated with acid, then washed to remove acid and salts by agitation with water, settling, and decantation); the clay is then made up with water to a known consistency; that is, each gallon of water should hold a certain weight of solids in an agitated solution.

The treatment of the silica is as follows: To render the material more easy of pulverization it is heated red hot and thrown into water; this causes the mineral to decrepitate. It is then ground and washed much

in the same manner as the clays, being run into vats and made up into a known consistency.

The feldspars and limestones are also ground until they are reduced to such an extreme state of subdivision that the particles remain suspended in the water.

The different materials having been brought to known consistencies, the combination of ingredients is made by allowing the required quantity of each fluid to flow into a common tank, where it is thoroughly agitated and pumped to a higher vat, from which it is carried to the drying floors, pans, or presses. After the excess of water is expelled and it has attained the consistency of putty, it is beaten and made into balls and stored away in rooms to ripen, which takes more or less time, according to the nature of the clays.

Where clays have been thoroughly washed at the banks, or when the coarser kinds of chinaware are to be produced, the process of conveying the raw materials through "launders" is sometimes omitted.

Investigations and analyses of the Japanese porcelain and crude clays (exhibited at the Centennial Exposition at Philadelphia) from which their finer grades of porcelain ware are manufactured, created considerable surprise to chemists who had hitherto taken it for granted that kaolin was the basis from which their porcelain was made. By reference to the subjoined analyses, made by Henry Wurtz, it will be readily seen that only one of the eight samples of Japanese clays (F) bears a resemblance in any chemical composition to kaolin. This was an astonishing revelation to those familiar with the manufacture and composition of porcelain.

	Tsuji-Chuchi	Shiro-Chuchi	Sakaime-Chuchi	Uwa-Kuszuri-Chuchi	Indo-Chuchi	Kudaru-yama-Chuchi	Sei-ji-Chuchi	Shira-Kawa-Chuchi	Eggshell Porcelain	Thick-body Porcelain
	A.	B.	C.	D.	E.	F.	G.	H.		
Silica	78.181	77.685	78.073	78.210	82.292	49.931	77.844	79.130	78.763	75.545
Alumina	15.699	15.189	13.993	14.407	11.981	38.738	13.510	16.440	17.847	19.315
Ferrous oxide	.663	.895	1.020	1.408	.130	1.582	1.530	1.289	.638	1.916
Lime	......	.146	.186	.097	.287	......	......	......	.213	.106
Magnesia	.099	.096	.229	......	.064	.206	.307	.240	.029	.176
Soda	1.744	1.469	1.722	1.385	2.981	1.445	} 3.993	1.490	{ 1.975	2.832
Potash	.551	.508	.961	.142	.506	.440			.203	.566
Manganeseoxide	trace.	.013	.031	......	.072	......	......	.150	......	......
Combined water	2.518	3.330	3.320	3.715	1.155	7.607	1.297	.910	......	......
Totals	99.430	99.331	99.545	99.464	99.477	99.949	98.481	99.640	99.668	99.456

A. The Tsuji-chuchi.

This is the most valuable and costly variety of the porcelain stone found at Idzumi-yama, and forms 70 per cent of the body of the finer eggshell porcelain. It is a dull white, porous, granular, coherent mass, not very unlike coarse chalk in appearance, but somewhat harder and very much tougher; breaks with difficulty; is rough to the touch, smearing the fingers, though not readily; fracture granular, conchoidal, dull; mass obscurely laminated(?). It adheres to the tongue, with a chalky taste, and has a distinct odor; much more of a chalky than a clayey character. It crushes grittily between the teeth, not at all with a sandy or quartzose grit, but

about like calcite. In the mass, under a low magnifying power, it has almost a saccharoid appearance, composed apparently of small granules, which have a distinct though dull luster.

B. The Shiro-chuchi.

This variety is also used in the eggshell ware to the extent of 30 per cent of the washed mineral. In the mass it is finer grained, harder, tougher, and more compact than A, but otherwise quite similar, having an equally white color and a like chalky taste and odor, adhering to the tongue, and smearing the fingers slightly (when hard rubbed), though without the slightest smooth or unctuous feel. Diffused throughout it are some small, dark colored specks not present in A; these, under the magnifier, are seen to contain slight nuclear remains of small crystals of iron pyrites. On blowpipe test these specks gave an iron reaction, but no permanent color was imparted to a phosphorus-salt bead in either the oxidizing or reducing flames. The proportion of finer material obtained by the same process of crushing and elutriation was much smaller than in the case of the Tsuji-chuchi, being but 25 per cent; but, except in the presence of a little lime and a little more iron, the composition of this washed portion does not greatly differ from that of A. The Shiro (like the Tsuji-chuchi), though dull to the eye, shows, under the magnifier, on the part of the granules which make up the mass, a distinct degree of luster, scarcely less than that of the fracture of the porcelain itself.

C. The Sakaime-chuchi.

This variety is used, with the Shiro-chuchi, in compounding the body of the thicker and commoner porcelain. There is little in its appearance to distinguish it, either by the eye or the magnifier, from the Shiro-chuchi, except possibly less hardness and a little coarser grain.

D. The Uwa-kuszuri-chuchi.

This variety is used in compounding glazes, in admixture with lixiviated wood ashes. It differs from the preceding varieties in being softer, smearing the fingers readily (without any clay-like smoothness, however), and it has throughout a good many dark specks, accompanied by points of iron pyrites visible under the lens. In other respects, its general description resembles the preceding companion minerals. After ignition and grinding, the powder was pale pinkish. Elutriation yielded 35 per cent of the mass.

E. The Indo-chuchi.

A great interest attaches to this variety from the fact, as stated by Dr. Wagener in his letters, that it still retains, in admixture, some of the unaltered mineral, from which he conceives all the four preceding kinds, together with the one which comes next (F), to have been derived by unknown processes of alteration. It presents a coarse-grained mass, rather regular in texture, color, fracture, and degree of porosity. In some places it is quite white, in others much stained with limonite. Scraping with a knife at once distinguishes some harder parts, or flakes, dispersed irregularly throughout the mass. With great labor a considerable quantity of this harder material was dissected out, and crushed to a coarse powder, in order to remove the remainder of the soft portions adherent, which was accomplished by grinding in a mortar with water, with a light pres-

sure, so long as the water became at all milky. A coarse, sand-like material was thus obtained having fully the hardness of unaltered feldspar.

Under the magnifier this presented the appearance of angular, opaque, milk-white fragments, conchoidal, and dull. No traces of feldspathic cleavages. Some grains show what appeared like encrusted, or possibly corroded surfaces, a little honeycombed and lustrous, which may indicate alteration. On ignition of these grains, they first blacken somewhat, apparently from presence of organic matter, but quickly burn white again. This behavior is very curious, differing from that of any of the associated minerals. No very marked odor accompanies this blackening, but the water given off has a distinct acid reaction, due very likely to sulphurous acid; so that the blackening may be due to the coexistence of a trace of sulphuric acid, or an acid sulphate with organic matter. Another curious fact about this Indo-chuchi was the development of a distinct musk-like odor from it when warm. After ignition most of the grains had assumed a reddish ferruginous tinge, some few, however, remaining white. The total iron in the mass, nevertheless, as shown by the analysis, is surprisingly small, being evidently also in ferrous form.

F. The Kudaru-yama-chuchi.

This is the variety also called Kesso-chuchi. It is, like the last, of especial interest, for several reasons, one of which is that this is the only variety presenting any approach, even in aspect, to a clay. It is a pure white, chalk-like substance, easily rubbed up between the fingers, with a slight unctuous feel, but quite inferior in this latter respect to a true clay. Under the magnifier it appears to be made up of very small, amorphous, transparent grains, irregular in size. In water it immediately falls to powder with effervescence (from escape of air), but the paste formed has very little of the plasticity of that formed by true clays.

It is chalk-like in odor, like the other minerals of the group, and shows no grittiness between the teeth. Even after ignition, and notwithstanding its very appreciable proportion of iron, its color remains pure white. Like all other related minerals, it may, when in powder, be fritted fast to a fine platinum wire by the intensest heat of the mouth blowpipe, though possibly with more difficulty than the others.

G. The Sei-ji-chuchi.

This one, as stated by Dr. Wagener, is not a companion material of the preceding six, not coming from the Idzumi-yama quarries, but from some other place in the neighboring country. The analysis was not, therefore, made by the absolute method. Like D, it is used as a glaze constituent for a peculiar green glaze. Its grain is much coarser and rougher than that of the preceding minerals, and it is very distinctly laminated in structure.

H. The Shira-kawa-chuchi.

This mineral—also, like the last, not from Idzumi-yama—is used in admixture with B and C in making the peculiar glaze for the crackle ware. It is white, with brownish bands and stains, finer grained than G, but coarser than the Idzumi-yama group, porous, rough to the touch, but smearing slightly, adhering to the tongue, with a chalky odor and taste, and had a feeble flesh-color in powder after ignition.

J and K.

Examination of the figures in the analyses of the eggshell and thick-body porcelains, and comparison of them with the analyses of the washed minerals, shows that while the correspondence in the case of the eggshell body is quite close enough to verify the formula given by the makers, in the case of the common porcelain there is quite a marked and decided departure from the composition that should follow from the specified mixture of components. Whether this discrepancy is due to variations in the composition of the Shira and Sakaime-chuchi (variations by no means improbable), or to some other cause, it seems almost useless, under existing circumstances, to conjecture. The deficiency of silica and excess of alumina, in the thick-body ware, over the minerals stated to enter into it, appears too large to be accounted for by the mere coating of Kudaru-yama-chuchi, which is given before glazing; but this may, nevertheless, have had some influence. We must rest satisfied with the important verification presented by the analysis of the finer eggshell ware, of the surprising fact that Japan porcelain, excelling all others in important characteristics regarded as normal for porcelain, par excellence, is made without the use of kaolin at all, or of any equivalent therefor; being compounded, as to its body, solely of the petuntse-like or petrosiliceous minerals. Indeed, the traditional principle, so often repeated in the literature of the art as a proverb of the Chinese, that while "the petuntse constitutes the flesh of porcelain, kaolin must form its bones," is proved here to be altogether inapplicable. It may also be submitted that a common popular belief regarding Oriental porcelain in general—which appears to have been altogether accepted since the celebrated memoir of Ebelmen and Salvétat was published, about 1850—that no essential technological differences exist between European and Oriental porcelain fabrication, should no longer be so implicitly accepted.

Among the clays from California analyzed in the State Mining Bureau, Number 11, from Carville, Trinity County, upon analysis was found not to be a true clay, being almost totally deficient in alumina. The crude material absorbs water readily, is perfectly white, and forms a somewhat plastic mass. It is probable that this material will form a desirable ingredient in the manufacture of porcelain. Experiments made upon the washed clay prove that, without any admixture whatever, the objects molded, whether in the form of thin sheets or in larger masses, retain their shape and become compact after subjection to the flame of the gas blowpipe, and that the thinnest sheets become vitrified and translucent.

CALIFORNIA CEMENT.

Since the last report of the State Mineralogist was issued, and which contained, among many other papers, an exhaustive article on natural and artificial cements, there have been discovered in different parts of the State several deposits of limestone necessary to the manufacture of this useful building material, and some of considerable importance by reason of superior quality.

One of these recent finds, in San Diego County, consists of fine concretionary limestone, so soft that it resembles precipitated carbonate of lime.

Samples from one of these many "soft lime" deposits give, by analysis, the following results:

Silica	1.86
Alumina	1.10
Carbonate of lime	94.28
Carbonate of magnesia	1.19
Carbonates of alkalies	1.15
	99.58

From the above class of limestone cement has been made at the crude works in San Diego, and the product, laid as sidewalks, proves entirely satisfactory. An analysis of this cement gave:

Lime	65.20
Magnesia	1.20
Silica	24.00
Alumina	5.24
Iron peroxide	2.21
Alkalies	1.00
Sulphuric acid	.20
Carbonic acid	1.00
	100.05

This cement corresponds very closely in composition to an English cement, the trade mark of which is K. B. & S. Until within the last six months, no Portland cement has been produced on the Pacific Coast. The Natural Cement Works at Benicia and Santa Cruz have lain idle for some time. It will be interesting, therefore, to reproduce the main facts in connection with this new enterprise, as given by a San Diego local paper:

The company reorganized to carry on this industry is called the Jamul Portland Cement Company, with Warren Wilson, President, W. P. Adams, Vice-President, and Benjamin McReady, Secretary. The plant is designed to produce two hundred barrels of cement a day—a regular working day of ten hours. The total annual product will reach between fifty thousand and sixty thousand barrels; but it will only supply a small portion of the cement required for California alone, which, last year, consumed between three hundred thousand and four hundred thousand barrels.

According to the San Francisco "Journal of Commerce," the amount of cement imported into this State during the year 1889 was two hundred and fifty-one thousand three hundred and ninety-nine barrels, costing, in Europe, $250,148. The falling off in the importation from the previous

year is due to the fact that the market was overstocked by a speculative movement. If the Jamul enterprise is a success, the works will be enlarged, the capacity trebled and quadrupled, and one of the city motor roads extended to the ranch where the limestone deposit exists. The plant will be erected in the Jamul Valley, as about sixty tons of the raw material will be consumed daily. A large warehouse will, however, be erected in San Diego.

The reorganized company starts, it is stated, with an ample cash capital, as well as with a definite purpose. Professor Leonhart, an employé, has gone to England and Germany, where he will spend two or three months studying the latest methods of manufacturing Portland cement. His knowledge, combined with the Professor's previous practical experience in the business, will be used in constructing the two kilns, the most important, perhaps, and the most delicate part of the whole enterprise.

President Wilson accompanied the Professor as far as Pennsylvania, where there are Portland cement works now in operation. Prices of machinery and estimates of costs of manufacture will here be obtained, in addition to that already in the possession of the company, and the preliminary work will have been accomplished upon Professor Leonhart's return. It is calculated that about the middle of April, 1890, the Jamul Cement Works will be turning out an excellent quality of material.

OTHER DEPOSITS.

On the mesa, or flat land, at the edge of the foothills, near Mission San Fernando, Los Angeles County, a shell limestone, much worn, is found, the cavities of which are filled with sand. An analysis shows it to be composed of the following constituents:

Sand	12.24
Insoluble silica	7.48
Soluble silica	.74
Alumina and peroxide of iron:	
Insoluble	1.62
Soluble	1.65
Carbonate of lime	72.68
Carbonate of magnesia	1.05
Chloride of sodium	.67
Water	1.76
Sulphuric acid	Trace.
	99.89

This limestone will make a Portland cement, if burned and afterward manipulated according to the English and French methods, of which a very full description is given in the article previously referred to.

At a point a little northwest of the town of Santa Barbara, a limestone has been discovered with the necessary composition for a good cement.

Near South Riverside, San Bernardino County, a dark limestone occurs, from which a good natural cement could be produced. The cement made from it would, however, carry the color of the stone, would set quickly, and not stand a great tensile or crushing strain.

A bed of marl, exposed near the City of Santa Cruz, would also make a good natural cement.

The last deposit that has come to notice is in the neighborhood of Port Costa. This is a crystalline limestone, soft and easily crushed, from which a good article of cement, as well as lime, could be made.

Its analysis shows:

Carbonate of lime	97.85
Carbonate of magnesia	.63
Chloride of sodium	.14
Silica	.26
Iron and alumina	.20
Water and carbonaceous matter	.50
	99.58

METEOROLOGICAL.

By Geo. E. Barnes.

The popular theory that cultivation of the soil, irrigation, the influx of population, and the construction of railroads, has a controlling effect upon the climate of a country, is subject to many modifications when applied to California. In fact it is doubtful whether these things have anything more than a moderative influence upon the meteorology of the Golden State. As a matter of fact the great storms which largely affect the weather and climate of California and Oregon have their birth, not among the foothills of the high Sierras, nor along the bold headlands of the coast, but are conceived, brought into being, and gather strength in the broad wastes of the north Pacific Ocean. Thence, driven by the irrefragable laws of nature, they seek the land. The great Japan current acts as a meteoric chariot for the Storm King, and wafts him shoreward. He is landed upon the southern coast of the Strait of Juan de Fuca. At Cape Flattery, the extreme northwest point of the United States, may be said to have been established by nature a mighty signal station. Cape Flattery is not only a storm center but it is the great rain center of the Pacific Coast. When Jupiter Pluvius touches its rock-bound limits his minions scatter in all directions, but those which travel to the south and east are more lightly burdened than their fellows that hasten toward the north. As the misty messengers are wafted inland they discharge their aqueous cargoes. Washington and Oregon get the largest share; then southward they drift into California, to that section back from Cape Mendocino to where the Sierra Nevada and the Coast Range unite in the grand mountain mass of Shasta. Here is the region of greatest rainfall in the State, the rain gauge showing from thirty to sixty-five inches of annual precipitation, while in some of the valleys surrounding the snow-clad peak, as much as one hundred and eight inches have accumulated in one season. The rainy season is, however, comparatively short, many inches being registered at a single downpour, with only an occasional thunder storm between June and October. In the high Sierras these occasional summer rains extend further southward, and the dwellers in the fertile valleys and along the productive foothills are often startled by the gathering of dark cloud-caps far above them and the crashing of the thunderbolt as the surcharged mass is broken against the mountain peaks, while directly overhead the sky is still blue, the air is soft and dry, and the face of the sun itself is not obscured. Following the trend of the great mountain range the rainfall averages twenty inches as far south as the headwaters of the Kings and Kern Rivers. From that point the precipitation lessens until the arid plain of the Mojave Desert is reached, where it does not exceed four inches per season. To better exemplify this course of the rainfall a record of the rain-gauge along the way is given: At Humboldt, on the coast, the mean annual precipitation is 34.75 inches; at Weaverville, Trinity County, it is 43.31; at Reed's Camp, Shasta County, 72.09 (during the season of 1880–81 it amounted to 95.46 inches); Mumford Hill, Plumas County, 69.27; Grass Valley, Nevada County, 48.79; Bu-

chanan, Fresno County, near the headwaters of Kings River, 18.78; and at Daggett, San Bernardino County, on the Mojave Desert, 3.98 inches. A similar peculiarity in the distribution of rainfall may be observed by following the record of the rain-gauge down the coast. The yearly mean precipitation at the several specified localities is as follows: Point Arena, Mendocino County, 30.49 inches; Petaluma, Sonoma County, 22.85; Point Bonita, Marin County, 25.43; San Francisco, 25.22; San Mateo, San Mateo County, 18.43; Santa Cruz, Santa Cruz County, 25.60; Monterey, Monterey County, 15.14; Pajaro, Monterey County, 18.12; San Luis Obispo, San Luis Obispo County, 20.75. Here Point Concepcion is reached, and southward the climate moderates and there is noticed a slight decrease in the precipitation. At Santa Barbara it is 17.29; at San Buenaventura, 16.87; Los Angeles, 16.03, and at San Diego, 10.26 inches.

It will be of interest to trace, in connection with the foregoing, the record of precipitation along the great valleys of the Sacramento and San Joaquin. Beginning near the headwaters of the former, at Red Bluff, Tehama County, the mean annual rainfall is found to be 24.55 inches; at Chico, Butte County, it is 20.32; Colusa, Colusa County, 16.85; Marysville, Yuba County, 16.22; Woodland, Yolo County, 17.59, and Sacramento City, 19.05 inches. Turning to the San Joaquin the rainfall is found to be lighter near its source, and to increase gradually as it makes its way down the valley. At Sumner, Kern County, the annual precipitation is but 5.38 inches; at Tulare City it is 6.62; at Fresno, 8.79; at Merced, 11.75; at Hills Ferry, Stanislaus County, 11.70; and at Stockton, where the San Joaquin joins the Sacramento, it is 13.91 inches. This valley, next to the Mojave plains, is the most arid section of the State. It is here that some very extensive schemes of irrigation have been inaugurated. What effect these may have upon the rainfall of the future is an unsolved problem.

THE RAINFALL.

The following table shows the average rainfall for each month in the year, together with the yearly average, and the greatest amount that has ever been precipitated during any season, as also the least amount at sixty-six places in California. The average mean is calculated from data gathered from records extending back from five to forty years, and has been carefully rearranged and prepared expressly for this report:

NOTE.—In places where there is a snowfall the snow has been reduced to rain, allowing ten inches of snow to one of rain.

Name of Station.	January	February	March	April	May	June	July	August	September	October	November	December	Yearly Average	Greatest Seasonal Precipitation	Least Seasonal Precipitation
Almaden	1.52	8.60	.92	.00	.00	.00	.00	.20	.05	.60	.80	14.29	-------	-------	-------
Alta	8.56	7.26	6.92	3.67	1.38	.51	T.	.00	.34	2.17	4.81	6.52	42.14	69.70	17.24
Arcata	5.85	6.07	3.08	7.38	1.32	.00	.00	.00	.00	3.19	1.17	9.03	37.69	-------	-------
Auburn	6.13	5.23	4.49	3.76	1.18	.36	.02	.01	.34	1.42	3.49	5.94	32.37	44.87	17.50
Blue Lake	12.66	7.34	3.98	8.14	2.08	1.04	.47	T.	2.08	1.91	16.68	20.08	76.46	-------	-------
Boca	4.26	3.43	2.68	1.51	.40	.13	.24	T.	.02	.57	.91	2.72	16.87	23.40	8.05
Bowman's Dam	14.00	11.07	10.77	7.78	2.59	.83	.20	.02	.71	3.65	7.94	14.00	73.56	102.22	14.37
Buchanan	2.60	3.12	3.00	4.33	.09	.14	.00	.00	.89	.46	.81	3.39	18.77	22.77	8.70
Byron	2.11	1.59	1.84	1.86	.32	.22	.00	.00	T.	.49	1.31	2.28	12.02	18.25	7.34
Cisco	10.83	10.74	8.79	5.22	2.36	.79	.11	.00	.28	2.17	4.56	9.25	55.10	80.46	34.00
Camp Far West	6.92	1.26	12.70	4.46	.86	.00	.00	.00	2.30	.10	3.96	8.64	41.20	-------	-------
Cherokee	8.37	7.55	7.95	3.37	1.49	.60	.11	.06	.51	2.95	5.40	6.59	44.93	63.26	28.35
Chico	3.92	3.57	2.28	1.73	.71	.34	.03	.03	.27	1.02	2.39	3.77	20.06	34.72	12.91
Calistoga	6.83	5.20	4.29	3.11	.79	.31	.00	.00	.23	1.78	3.06	4.89	30.49	50.20	7.33
Colfax	8.36	6.77	6.28	4.97	1.63	.52	.00	.00	.32	1.74	5.06	7.67	43.33	60.06	27.61
Colusa	3.67	2.82	1.86	1.54	.49	.37	.04	.02	.19	1.04	1.82	3.17	16.99	32.84	9.20
Crescent City	13.69	10.44	6.29	8.58	2.75	2.31	.65	.08	3.49	10.22	11.37	18.90	88.77	135.43	69.72
Daggett	.48	1.44	1.25	.15	1.09	.05	.00	.00	.03	.00	.00	2.40	6.45	-------	-------
Delta	6.65	3.56	7.03	8.66	4.55	2.03	.05	.00	.02	4.54	6.70	9.21	53.00	75.24	33.30
Emigrant Gap	10.18	9.50	8.77	5.65	2.47	.74	.02	.01	.32	2.45	3.25	8.13	51.49	85.17	18.64
Firebaugh Ferry	1.78	1.14	1.12	.94	.16	.17	T.	T.	.07	.31	1.51	1.28	8.48	18.84	2.24
Fort Gaston	10.56	7.99	7.50	4.70	1.74	.75	.12	.11	.89	2.67	7.69	10.70	55.42	125.36	31.72
Fort Jones	2.88	4.10	2.77	1.25	1.21	.69	.06	.07	.20	1.39	2.59	4.39	21.60	32.03	18.89
Fresno	1.30	1.21	1.21	1.64	.30	.13	.00	.00	.12	.39	1.21	1.28	8.79	16.62	4.87
Georgetown	11.09	8.52	8.78	7.20	2.30	.82	.06	T.	.46	3.47	6.18	9.94	58.82	81.24	40.48
Gilroy	5.07	2.95	2.76	2.05	.40	.13	T.	.01	.20	.86	2.05	3.02	19.50	31.04	6.53
Grass Valley	10.03	7.10	7.57	5.61	1.90	.62	.05	.01	.69	2.81	6.06	8.17	50.62	65.32	30.23
Hanford	1.71	1.62	1.81	1.72	.27	.24	.00	.01	.04	.45	1.62	2.10	11.59	-------	-------
Healdsburg	5.52	9.31	2.28	.95	.39	.08	.00	.02	.24	.11	1.81	15.22	35.93	-------	-------
Hollister	2.42	1.83	1.67	1.25	.33	.19	.02	T.	.09	.55	1.32	1.49	11.16	18.12	4.69
Ione	2.88	3.28	3.06	3.39	.81	.30	.00	.00	.18	.91	1.67	2.86	19.34	29.73	13.04
Jackson	5.18	4.69	4.88	5.17	1.34	.32	.00	.00	.42	1.66	3.04	4.86	31.46	37.90	21.20
Los Angeles	3.93	3.76	1.90	1.34	.35	.09	T.	.08	.01	.39	1.49	2.73	16.03	32.16	8.97
Los Gatos	6.41	5.60	1.68	3.59	.15	T.	.02	.00	.03	.49	6.99	4.00	28.96	-------	-------
Marysville	3.28	2.46	1.84	1.63	.59	.25	.01	.01	.19	.89	1.74	3.33	16.22	20.86	6.65
Merced	2.65	1.41	1.44	1.78	.54	.19	.01	.00	.10	.43	1.24	1.96	11.75	30.83	3.03
Mendocino	9.90	8.90	7.36	4.77	1.31	.39	.08	.05	.45	2.00	5.51	7.96	49.28	80.97	29.19

Modesto	1.72	1.21	1.19	1.14	.33	.11	.01	.00	.09	.40	1.06	1.54	8.80	13.54	2.25
Mojave	.59	1.33	.40	.25	.01	T.	.06	.00	.03	.10	.37	.91	4.05	9.96	.00
Monterey	2.13	2.18	3.03	1.81	.41	.22	.04	.01	.86	.57	1.44	2.52	14.42	21.45	9.16
Nevada City	10.93	7.68	8.57	5.14	2.06	.60	.04	.03	.54	1.82	6.67	12.09	56.27	115.26	17.28
North Bloomfield	9.37	7.81	7.58	5.73	2.04	.64	.12	.02	.60	2.90	5.84	9.83	52.48	74.52	27.87
Oroville	3.49	3 11	1.25	2.42	.29	.10	T.	T.	.57	.80	3.34	9.46	24.83	31.21	18.46
Point Reyes	4.29	3.24	3.94	4.06	.76	.20	.00	.00	.30	1.37	3.81	6.12	28.09	....	....
Redding	7.07	4.98	3.91	3.66	1.45	.45	.05	.06	.37	1.89	3.62	6.74	34.25	59.92	8.78
Red Bluff	5.97	3.87	2.54	2.18	.78	.37	T.	.05	.41	1.22	2.84	3.76	23.99	61.65	13.52
Rocklin	3.95	2.97	2.56	2.10	.65	.25	.02	.01	.10	.80	1.74	3.59	18.71	26.06	10.26
Sacramento	3.71	2.77	2.95	1.90	.67	.12	.03	T.	.12	.66	2.12	4.53	19.41	36.36	4.71
San Bernardino	3.66	3.05	1.97	1.75	.44	.06	.02	.08	.05	.43	1.58	3.10	16.17	37.51	8.98
San Buenaventura	3.86	3.57	2.37	1.48	.38	.27	.00	.00	.01	.44	1.96	2.53	16.87	....	....
Santa Barbara	3.87	3.88	1.90	1.61	.33	.12	.00	T.	.04	.46	1.49	3.59	17.29	34.47	4.19
Santa Cruz	6.18	3.98	3.18	3.03	.51	.34	.01	.01	.32	1.36	3.53	3.79	25.24	36.41	16.48
San Luis Obispo	4.68	3.75	2.81	2.05	.35	.14	T.	T.	.03	.72	1.95	4.53	21.01	42.40	8.15
San José	2.70	2.49	2.47	1.97	.41	.20	T.	.00	.10	.53	1.16	1.78	13.18	21.17	4.99
San Diego	1.55	2.22	1.38	.90	.44	.07	.01	.19	.03	.29	1.02	2.16	10.26	25.97	3.71
Smartsville	7.11	5.70	4.48	3.16	.88	.44	.05	.00	.11	1.50	3.74	5.01	32.18	46.78	17.99
Sonoma	4.88	6.02	1.15	3.54	.29	.00	T.	.00	T.	.95	6.83	3.41	27.08	....	....
Stockton	2.67	2.46	2.14	1.65	.55	.15	.01	.00	.05	.50	1.11	2.62	13.91	22.04	6.87
Summit	8.39	8.96	6.78	5.77	1.68	.62	.08	.01	.19	2.34	2.82	7.32	44.96	87.99	23.34
Sutter Creek	6.56	4.91	4.90	4.78	1.33	.44	.03	.02	.26	1.80	3.88	4.28	33.19	....	....
San Francisco	5.06	3.76	3.07	2.04	.62	.15	.02	.02	.16	.85	2.85	5.20	23.80	49.27	7.40
Tehama	2.70	2.37	1.64	1.37	.54	.24	.05	.06	.18	.74	1.91	2.12	13.92	29.82	5.16
Tulare	1.29	1.23	.93	1.18	.31	.10	.01	.00	.02	.16	.44	.97	6.64	11.65	3.07
Ukiah	6.88	4.78	4.57	3.52	.98	.12	.00	.01	.48	1.43	3.94	6.21	32.92	54.88	19.88
Watsonville	4.85	4.74	2.14	1.76	.59	.00	.00	.00	.10	1.17	1.75	7.43	24.53	....	....
Yreka	3.19	1.75	1.55	1.04	.83	.39	.26	.08	.37	1.46	1.77	2.52	15.21	22.48	10.53

THE FOGS.

An important factor in considering the meteorology of California, particularly of the coast counties, is the fogs. Although not generally included in considerations of rainfall measurements, they produce effects nearly related to rainfall. The temperature of the Japan current is almost uniform throughout the year. As the land becomes heated above or cooled below this temperature, the contrast resulting in close proximity creates these fogs. In summer, so wide is the difference that the comparatively cool ocean is lined with a wall of thick fog vapor that rises one thousand feet or more, rolling in upon the mountains, and, where a gap occurs, forms a river of fog, as Lieutenant Glassford terms it, submerging everything in its path; broadening and branching out, it follows up the valleys until dissolved by the dry air of the interior. These fogs add considerable moisture, and not infrequently five hundredths of an inch of water will be precipitated in a single night.

The rainfall tables show that in ascending the west side of the Sierras the precipitation increases at the rate of about one inch for each one hundred feet of elevation. In descending the eastern slope, however, it decreases more rapidly. In the mountain towns of Nevada, Placer, El Dorado, and Amador Counties the midday temperature during the summer months does not vary much from that of places in the Sacramento Valley, but the nights are cooler, and the winter climate is cold. In places, at an elevation of three thousand feet, ice forms five or six inches thick, and there is generally snow enough for sleighing. At points six thousand feet above the sea level snow five or six feet in depth covers the ground for four or five months in the year. The temperature falls regularly as we ascend the Sierras, and continues to decline after we begin to descend on the eastern side, the January climate of Truckee being several degrees colder than that of Cisco, which is at a higher elevation on the western slope. The heat of midsummer increases until an altitude of three thousand feet is reached, and then begins to decline. In this connection the following table, giving the result of meteorological observations at several mountain and mining towns, will be of interest. It shows the elevation, average mean temperature for each division of the year, the highest and lowest temperature, and the annual average rainfall:

Name of Station.	Elevation—Feet	Average Winter Temperature	Average Spring Temperature	Average Summer Temperature	Average Autumn Temperature	Average Annual Temperature	Highest Temperature	Lowest Temperature	Average Seasonal Rainfall
Anderson	432	50.0	59.3	80.7	60.2	62.6	114	20	39.97
Auburn	1,363	42.6	56.4	74.3	61.7	59.7	106	13	33.15
Chico	193	47.3	62.4	81.3	64.2	63.8	110	18	20.84
Colfax	2,421	46.0	55.9	76.0	60.2	59.5	106	16	45.16
Cisco	5,939	32.1	42.6	58.9	50.8	46.1	82	0	55.10
Ione	287	49.1	60.5	78.0	64.6	64.0	110	19	20.06
Marysville	69	50.1	62.7	78.3	65.6	64.2	108	18	16.60
Nicolaus	40	50.9	57.7	77.7	61.7	62.0	111	18	19.57
Oroville	171	52.0	64.5	78.8	64.3	64.9	102	20	22.11
Red Bluff	307	46.8	59.8	79.7	63.2	62.4	110	16	27.46
Summit	7,019	28.3	39.1	56.6	48.0	43.0	81	12	44.96
Tehama	220	47.7	61.9	81.3	64.1	63.8	115	21	15.39
Truckee	5,846	27.9	50.6	62.7	50.5	47.9	88	30	-----

THE CLIMATE.

The mild climate with which California is blessed is largely owing to the influence exerted by the Japan currents. Similar to the Gulf Stream, this immense tropical river of the sea, crossing from the shores of Asia, courses eastward and southward and strikes our coast, diffusing a genial tinge to the temperature, and making itself felt far down toward the Mexican border. The ocean breezes as they pass over it during the summer months are softened and subdued, and carry its balmy influence to the fair inland valleys, where they render healthful and invigorating the atmosphere, which would otherwise be oppressive. As these winds blow steadily for six months from the westward upon the whole coast line of the State, and there is little variation in their temperature, it follows that there is a general similarity of climate from the northern to the southern boundary, being modified only by the physical conditions of the land. Thus it is found that localities similar as regards neighboring mountain ranges have a similar climate, though one may be five hundred miles north or south of the other. It must be understood that the coast counties which receive, unobstructed, the winds from the sea, have one climate; the small sea coast valleys, separated from the sea by mountain ranges, have another, warmer because more sheltered, and thus more exposed to the influence of the sun; and the great interior valleys have a still higher temperature, because they are hemmed in on all sides by high mountain ranges.

THE TEMPERATURE.

The following table gives the monthly mean temperature at a large number of places in California. The observations were mostly made in the year 1888, and in a majority of cases were compiled by Nelson Gorom, observer, Signal Corps, San Francisco:

Stations.	January	February	March	April	May	June	July	August	September	October	November	December	Annual Means	Highest Observed	Lowest Observed
Almaden	46.6	54.2	54.5	61.2	62.3	68.6	70.6	72.5	69.4	64.2	56.6	54.7	61.3	102	27
Anaheim	55.6	58.5	59.5	66.9	69.9	73.5	71.3	72.1	74.8	69.3	63.4	60.9	66.3	94	34
Aptos	46.0	51.9	53.0	58.4	59.7	67.9	65.9	63.2	61.8	59.1	53.9	54.1	57.9	88	19
Auburn	40.4	50.9	51.3	61.4	61.0	66.9	76.5	79.5	76.9	64.2	52.9	47.1	60.8	105	12
Bishop Creek	33.4	50.9	56.3	69.6	78.1	86.0	87.7	91.7	81.7	65.3	48.9	38.8	65.7	105	3
Boca	15.8	27.6	33.4	42.5	53.4	58.4	67.9	63.6	60.4	43.5	33.5	31.2	44.3	95	39
Byron	41.8	56.5	59.4	69.2	69.5	72.2	80.3	84.5	79.0	69.1	57.9	53.2	66.6	108	22
Caliente	47.0	55.4	53.3	67.9	74.1	75.1	83.5	82.1	82.9	69.7	56.5	52.9	66.7	107	20
Calistoga	44.4	53.7	55.1	60.3	58.5	64.8	63.3	68.7	65.8	61.7	54.7	52.7	59.8	108	22
Chico	42.6	54.9	56.4	70.9	71.6	75.1	86.0	86.2	83.0	67.2	54.7	51.4	67.1	111	18
Cisco	27.8	33.0	34.8	44.8	48.2	51.1	63.4	62.3	62.6	50.2	39.7	35.7	46.1	82	
Colfax	37.8	47.8	49.0	60.4	61.2	65.4	75.0	76.8	73.7	60.9	50.7	47.6	58.9	102	16
Davisville	43.4	50.7	53.1	65.1	66.8	69.9	77.1	76.9	71.4	65.3	57.0	53.5	62.5	111	19
Delta	33.7	45.8	44.4	62.3	66.4	67.4	77.2	76.4	74.6	61.2	54.2	48.7	59.4	105	10
Elmira	44.6	54.4	56.6	64.4	65.4	73.1	78.1	82.5	80.6	65.8	59.0	53.0	64.8	113	24
Emigrant Gap	32.3	40.1	38.7	53.9	53.0	54.7	64.7	67.3	66.7	54.9	43.6	40.4	50.9	86	8
Eureka	44.6	48.1	47.7	50.9	53.0	58.8	56.5	—	56.5	53.0	50.2	53.0	52.0	—	20
Fresno	44.1	53.2	54.1	67.1	68.6	74.0	80.6	83.0	80.3	66.2	53.7	47.8	64.4	111	20
Galt	46.8	47.5	53.1	68.2	68.7	72.7	80.1	78.6	73.8	65.8	56.0	49.6	63.4	108	20
Gilroy	44.8	51.1	52.3	62.0	61.8	71.9	71.4	74.1	70.8	61.7	55.4	51.4	60.7	104	20
Goshen	44.6	54.1	56.9	70.9	74.6	80.7	88.8	90.3	85.8	70.7	58.8	49.0	68.8	110	16
Hollister	47.6	54.3	54.9	60.9	61.3	67.9	68.4	68.4	63.7	59.0	53.9	53.5	59.5	104	21
Hornbrook	22.0	41.3	47.0	58.5	63.9	66.0	70.9	77.4	73.1	57.6	43.2	41.6	55.2	104	12
Indio	47.8	60.3	62.3	75.6	74.2	89.7	96.9	95.4	93.6	79.8	65.0	55.7	74.7	112	22
Ione	42.6	50.6	50.5	61.3	65.4	75.1	80.6	82.3	78.5	67.1	59.9	58.2	64.3	110	17
Knights Landing	41.3	50.5	51.0	60.3	66.3	67.2	74.3	73.6	74.0	64.5	53.6	48.8	60.4	105	20
Lathrop	44.9	52.6	53.3	64.3	65.7	72.6	75.4	75.3	71.1	61.8	54.7	47.8	61.6	112	23
Lemoore	43.8	50.6	53.6	66.8	65.2	74.6	82.8	83.4	82.8	66.0	52.7	46.9	61.1	113	18
Los Angeles	50.0	54.4	55.1	61.9	60.8	67.5	67.9	67.6	68.4	62.0	57.2	55.2	60.7	99	31
Los Gatos									70.8	64.4	55.0	52.4	60.6	—	—
Mammoth Tank	49.6	59.4	63.0	82.0	82.6	93.4	97.2	96.0	93.9	78.6	61.3	52.0	75.7	117	27
Martinez	44.0	53.1	49.7	58.9	58.6	70.7	74.3	68.3	67.8	63.5	54.2	50.8	59.5	94	20
Marysville	54.5	57.5	63.9	70.4	70.2	78.8	81.3	81.4	77.0	67.4	52.7	47.7	67.0	106	20

Menlo Park	45.8	52.5	51.4	59.0	60.4	67.0	70.2	69.5	66.7	61.7	55.2	53.1	59.4	101	20
Merced	47.1	54.6	54.2	65.9	69.3	76.3	83.4	83.0	77.7	68.5	58.0	50.8	65.7	120	20
Modesto	44.2	50.8	54.4	68.2	66.1	73.4	80.9	86.6	80.7	64.7	52.7	50.4	64.3	110	19
Mojave	43.7	52.1	53.7	71.0	67.6	73.1	81.2	85.3	93.9	69.4	58.4	51.8	66.8	115	16
Montague	......	40.8	49.9	61.9	65.4	65.6	80.3	85.9	74.3	61.9	44.1	40.4	61.8	104	—
Monterey	49.7	54.8	54.6	57.5	60.0	64.8	64.6	63.1	62.5	59.5	53.7	55.2	58.2	90	20
Napa	44.6	49.5	51.8	56.4	60.4	69.8	69.3	67.2	65.8	60.4	52.7	51.0	58.2	100	21
Newhall	45.5	50.9	54.9	65.1	64.0	71.5	77.6	75.2	76.6	63.9	52.9	49.8	62.7	108	14
Oakland	47.4	52.6	51.0	57.6	57.0	62.9	62.5	61.4	60.8	69.1	54.2	52.1	56.6	80	28
Orland	44.5	54.8	53.9	69.0	70.7	75.3	85.1	85.5	84.3	74.8	57.5	51.1	67.2	115	22
Pajaro	47.1	53.1	52.1	56.0	58.3	63.1	63.5	61.4	62.3	60.8	55.6	55.8	57.4	89	20
Paso Robles	44.1	47.8	51.9	62.3	64.0	71.7	73.5	74.4	71.0	60.4	51.3	47.9	60.0	108	13
Petaluma	44.2	50.8	49.0	57.3	57.8	61.2	68.2	67.3	65.0	65.0	55.1	51.3	57.7	97	18
Placerville	......	......	......	......	......	......	74.5	73.2	71.4	57.9	49.9	46.8	62.3	103	—
Pleasanton	48.1	53.7	54.9	61.8	63.4	69.8	74.7	75.7	75.7	67.8	51.3	51.6	62.4	104	22
Red Bluff	40.9	53.9	54.5	67.0	68.1	70.7	80.9	83.6	81.2	68.2	54.8	48.3	64.3	109	18
Redding	39.2	52.4	55.3	69.6	74.2	72.5	83.0	80.9	81.5	66.4	48.5	53.9	64.8	106	18
Rocklin	42.7	49.8	52.5	59.7	64.0	70.2	79.9	82.1	78.4	66.8	55.0	48.5	62.5	106	20
Sacramento	42.8	52.6	53.6	62.3	61.8	67.7	71.6	75.4	73.7	64.2	53.6	48.4	60.6	108	19
Salinas	44.1	49.7	48.6	56.2	58.1	68.4	66.2	60.3	59.3	57.3	50.8	52.2	55.9	87	21
San Diego	51.6	54.9	55.8	60.8	61.2	65.9	68.4	68.4	68.2	63.5	58.8	56.5	61.2	93	33
San Fernando	44.6	52.4	55.6	69.5	62.1	75.1	76.4	74.9	76.7	68.2	58.6	55.1	64.1	108	28
San Francisco	46.3	52.8	52.5	56.2	55.4	61.0	59.1	57.8	59.0	58.6	55.1	52.4	55.5	93	29
San José	46.4	52.6	52.8	58.3	59.8	65.2	66.8	68.6	68.0	62.3	56.5	52.9	59.2	93	22
San Mateo	46.5	51.2	51.7	58.3	58.2	67.1	69.7	66.7	62.8	58.1	49.3	50.6	57.5	92	26
San Miguel	43.2	52.5	54.5	61.2	62.2	69.5	69.9	73.2	70.5	62.5	54.4	50.9	60.4	106	17
Santa Barbara	48.4	56.1	54.8	62.6	62.8	70.7	72.5	69.0	67.0	65.0	59.6	55.8	62.4	82	30
Santa Cruz	49.2	53.1	54.8	59.3	59.3	67.5	66.4	64.4	65.8	66.3	58.0	57.1	60.1	98	24
Sisson	......	......	43.4	60.3	45.4	57.1	66.1	69.2	63.1	53.4	44.6	41.0	54.4	104	—
Soledad	42.1	50.4	50.5	59.2	57.6	63.4	64.8	63.7	63.2	58.1	51.1	49.1	56.1	104	16
Soquel	50.3	52.2	53.6	59.6	61.0	68.4	69.5	63.7	61.4	61.3	51.5	55.0	59.0	94	18
Stockton	44.3	51.1	53.6	62.3	62.0	68.1	71.1	74.9	72.3	62.2	53.3	49.6	60.4	102	24
Summit	22.4	30.9	30.5	40.7	45.9	50.1	60.0	59.6	59.7	48.7	35.5	31.7	43.0	81	12
Sumner	46.5	54.9	57.7	73.5	75.7	83.2	91.7	89.4	86.5	68.4	—	—	72.8	110	20
Tehama	41.1	54.6	54.7	65.9	65.4	68.6	78.8	81.1	72.7	64.5	57.9	55.0	63.4	110	21
Towles	34.5	46.4	49.3	53.9	60.9	55.0	69.0	60.8	62.6	54.1	51.3	43.2	53.4	95	8
Truckee	20.2	29.6	53.6	46.5	51.6	56.0	67.3	64.9	61.6	50.6	39.3	34.0	47.9	88	30
Tulare	44.0	51.5	57.0	73.0	75.0	80.5	86.4	85.0	81.1	71.9	61.7	50.2	68.1	113	18
Turlock	45.7	53.2	55.9	64.6	67.0	74.1	78.2	81.6	76.5	65.2	54.6	53.1	64.1	109	21
Williams	46.1	53.4	52.6	64.1	68.9	79.0	87.9	82.9	84.8	74.3	55.1	47.9	66.4	110	19
Willows	40.3	51.1	51.6	64.1	67.2	70.9	79.8	78.8	84.2	67.8	52.5	47.6	63.0	105	20

A PHENOMENAL WINTER.

The phenomenal winter of 1889–90, which is the most severe experienced on the Pacific Coast since the period of American occupation, has played havoc with the meteorological tables of the past. In San Francisco, where the average seasonal precipitation is 23.80 inches, 33.22 inches had fallen up to the twenty-fifth of January. At Auburn, where the average season's rainfall to December thirty-first is 9.22 inches, there had fallen up to that date in 1889, 23.54 inches. At Emigrant Gap, 44.12 inches of rain and snow (the latter reduced in the computation to rain) had fallen for the season up to December, 1889, against 14.18, the average to the same time in previous years. At Dunsmuir, on the California and Oregon line, where the snowfall does not usually exceed four or five feet, the ground was covered to a depth of twelve and fifteen feet. At Grass Valley snow had fallen by the middle of January to such a depth as to shut out all communication with the outside world except by means of snowshoes. On the line of the Central Pacific in the Sierra, the snow, on the twenty-fifth of January, varied from twenty-five feet in depth at Summit, to ten feet at Truckee. While this unprecedented precipitation of rain and snow has caused much interruption to travel and some damage to property in the northern and central portions of the State, it will have the effect of furnishing an abundant amount of water for the service of the miners during the coming summer season. Before the early rains in October last, many weather-wise persons were firmly of the opinion that the year 1890 would be a dry one. They based their belief on the fact that in every thirteenth year since 1851 there had been an insufficient amount of rain. In 1851 the precipitation amounted to but 7.40 inches; in 1864, 10.08 inches, and in 1877, 11.04 inches. These figures are taken from the records at San Francisco, but of course afford a good average for the rest of the States. The heavy downpours, however, which continued during November, December, and January, demoralized the "thirteen-year cycle" people, and the general belief now seems to prevail that the Golden State will never again be visited by what can properly be termed a dry year. The temperature, although there have not been so many severe frosts as in some seasons, has been at most places much lower than last year, which was to be expected from the large amount of rain and snow that has fallen.

Although this report properly closes with the year 1889, because of the severe season and the desire to have as late data regarding the rainfall as possible, this portion of it has been held back for several weeks. The cessation of the great storm on the twenty-fifth of January afforded an opportunity to obtain much matter of value in this connection. Of course, the January reports will be found very imperfect. Because of the serious blockade in the mountains it was found impossible to obtain the regular daily reports that are forwarded to the railroad company. In many instances these reports were sent eastward as far as Denver, and thence telegraphed to this city by way of Mojave. Thus, while the snowfall is greater than ever known before during January, the data at hand fails to show it. By consulting such data as was to be obtained from Mr. Price, the meteorological expert of the Southern Pacific Company, and Lieutenant Maxfield and Sergeant Gorom of the United States Signal Service, a great deal of important and interesting information has been secured. This will be found in the following table, which has been arranged to include the twenty-sixth of January, 1890. It shows the rainfall to that date during the month, also the season's rainfall to December 31, 1889, together with the average seasonal rainfall to December thirty-first, gathered rom obser-

vations at a number of stations, extending back from two to forty years. In speaking of the season's rainfall, it must be understood that the calculation begins on the first of July preceding. The rainfall for October, November, and December, 1889, are given separately, and for the purpose of comparison, the average rainfall for the same months in past years. The mean temperature for December, 1889, and the mean annual temperature for December is also given. It should be borne in mind that in reducing the rain to snow, it is estimated that ten inches of the latter make one of the former.

Name of Station.	Season's Rainfall to December 31, 1889	Rainfall for October, 1889	Rainfall for November, 1889	Rainfall for December, 1889	Rainfall for January, 1890, to twenty-sixth day	Average Season Rainfall to December 31	Average October Rainfall	Average November Rainfall	Average December Rainfall	Average January Rainfall	Mean Temperature for December, 1889	Average Mean Temperature for December
Auburn	23.54	5.75	4.85	11.94	7.92	9.22	1.42	3.49	5.94	6.13	47	46
Boca	25.40	1.50	3.65	19.30	*3.50	4.46	0.57	0.91	2.72	4.26	29	29
Chico	20.13	7.80	2.59	9.74	5.54	7.51	1.02	2.39	3.77	3.92	....	....
Cisco	47.25	12.14	9.54	25.57	*10.30	16.37	2.17	4.56	9.25	10.83	31	34
Colfax	41.40	9.95	9.60	21.85	*13.10	14.79	1.74	5.06	7.67	8.36	....	....
Delta	62.58	26.71	10.03	25.83	*2.68	20.52	4.56	6.70	9.21	8.66	42	43
Dunsmuir	52.38	20.15	11.65	20.51	*8.50	....	....	....	....	....	29	....
Emigrant Gap	44.12	11.81	11.41	20.85	*14.00	14.18	2.45	3.25	8.13	10.18	31	39
Grass Valley	42.32	12.49	8.75	21.08	....	17.69	2.81	6.06	8.17	10.03	....	....
Ione	14.27	4.71	3.15	6.41	3.41	5.92	0.90	1.67	2.86	2.88	....	....
Iowa Hill	38.73	9.23	8.49	21.04	....	....	....	....	....	....	....	....
Marysville	18.63	5.87	3.73	9.01	5.17	6.17	0.89	1.74	3.33	3.28	....	....
Placerville	36.12	8.85	8.20	19.07	11.31	15.32	2.90	5.48	7.82	9.10	....	....
Red Bluff	21.21	8.39	2.99	9.80	3.27	8.28	1.22	2.84	3.76	2.18	....	....
Redding	37.86	15.13	5.07	17.66	4.62	12.73	1.89	3.62	6.74	3.66	44	43
Rocklin	16.14	4.97	3.68	7.52	4.83	6.26	0.80	1.74	3.59	3.95	....	....
Sacramento	16.90	5.62	2.47	6.37	5.13	7.46	0.68	2.06	4.52	3.77	....	....
San Francisco	24.00	7.28	2.90	13.81	9.22	9.10	0.85	2.85	5.20	5.06	51	53
Sisson	38.41	16.45	5.80	16.13	*9.20	....	....	....	....	....	33	....
Summit	33.35	8.05	6.80	18.50	*10.40	12.76	2.34	2.82	7.32	8.39	28	31
Tehama	26.44	11.58	3.41	11.45	5.68	5.06	0.74	1.91	2.12	1.37	49	47
Truckee	....	3.13	3.97	14.51	*6.50	8.00	1.24	2.11	4.35	5.98	....	....
Vina	21.92	7.24	2.59	12.16	4.24	....	....	....	....	....	47	....

*At these mountain points the wires were down a good share of the time during the month, and the reports were furnished very irregularly. The rainfall, or rather the snowfall, was much heavier than appears from this table.

COAL PRODUCT.

The coal product of the State of California during the years 1888 and 1889, as nearly as can be ascertained, is as follows:

	Tons—1888.	Tons—1889.
Empire Mine, Mt. Diablo District, Contra Costa County	22,000	38,000
Pittsburgh Mining Co., Mt. Diablo District, Contra Costa County	34,795	33,718
Ione Valley Mines, Amador County	24,404	30,000
Chaney Mine, near Elsinore, San Diego County, estimated	....	5,000
Mines in Fresno County, estimated	....	2,000
Corral Hollow and Livermore group of mines, Alameda County	....	3,000
All others, estimated	1,801	....
	85,000	111,718

The amounts are given in tons of two thousand pounds each.

For the Empire, Pittsburgh, and Ione Valley Mines, the figures are from the books of the companies. The rest, as stated, are estimated.

THE MANUFACTURE OF GLASS IN CALIFORNIA.

HISTORY, CONDITION, AND FUTURE OF THE BUSINESS.

By Dr. Henry De Groot.

PECULIAR PROPERTIES OF GLASS, AND HOW IT IS MADE.

Glass is made by the fusion at a high temperature of silica with one or more bases, one of which must be an alkali. The material used in its manufacture consists of about 15 per cent alkali, usually soda, and 75 per cent silica, with small quantities of lime and alumina, the other ingredients added depending on the kind of article to be made.

Glass possesses properties both physical and chemical of a very rare kind, adapting it for many useful as well as artistic and ornamental purposes. Besides being hard, brilliant, and transparent, it resists the influence of all common solvents, being acted upon by none of the acids except the hydro-fluoric, which, however, attacks it vigorously, combining with and removing its silica. It withstands the action of the other acids even better than the precious metals. Exposed to water at its ordinary temperature glass is not sensibly affected, though very hot water tends to dissolve it slowly. The surface also becomes clouded through long exposure to moist atmosphere.

KINDS OF GLASS MADE IN THIS COUNTRY.

The different kinds of glass made in the United States consist mainly of plate, in the several conditions of rough, rolled, ribbed, and polished; flint, including table and other wares, both blown and pressed, together with a large variety of bottles, vials, jars, etc., also a coarser, greenish style of bottle, water glasses, and similar cheap wares. The means by which the fused material is caused to assume its varied forms are by blowing, casting, and pressing into molds, an operation in which the other two processes may be partly combined. In this State the manufacture of glass is at present confined to a small number of articles in the above list, the different kinds of goods made here being fewer now than formerly.

GLASS MAKING IN CALIFORNIA—THE SEVERAL COMPANIES THAT HAVE HERE LIVED AND DIED.

A demand for certain cheap glasswares, such as beer and soda bottles, fruit jars, etc., sprung up here at an early period in our history, the call for other and more costly goods in this line coming in a little later. To meet this demand a San Francisco company, engaged in putting up fruits and vegetables, erected here in 1858 works for making articles for their own use, these being the pioneer glass works on the Pacific Coast. Owing to lack of skill on the part of the workmen, and the inferior quality of the sand employed, the wares turned out proved worthless, whereupon the company, after a vain endeavor to supply these deficiencies, abandoned the *enterprise.*

A similar venture, entered upon soon after by other parties, having had a similar issue, no further attempt was made to establish here this branch of business until 1863, when the Pacific Glass Company put up a factory on the Potrero, commencing operations the same year. This company, which made all kinds of bottle glass except flint, gave employment to seventy-five men and boys, and produced annually commodities to the value of $130,000. This factory was equipped with one furnace and seven open pots for melting, its capacity having afterwards been somewhat enlarged.

In 1866, the San Francisco Glass Works, giving employment to about forty hands, and producing yearly wares to the value of $40,000, were founded. At this factory were made bottles, jars, demijohns, lamp chimneys, and druggists' articles, besides a few large size retorts for chemists, laboratories, and acid works, these being about the only goods in this line that could at that time be made here with profit.

Nor were the profits realized on these cheap, coarse articles by any means inordinate. It took these pioneer glass makers, in fact, a good while to get the business established on a paying basis. Finding competition for a limited market to be a losing business, these two companies formed, a few years later, a consolidation, and were afterwards conducted under their joint name.

Since that time several other glass manufacturing companies have entered the field, but they have all proved short-lived. Two of these, one operating at Oakland and the other at Berkeley, engaged in the business on a large scale, but after a short trial both closed their works, the venture proving commercially unprofitable. Since the retirement of these parties the San Francisco and Pacific Company alone remains, constituting, it must be supposed, an example of the survival of the fittest. But, while this company has so been able to survive all its contemporaries, it has not, for reasons to be noticed further on, been able, in certain lines of goods, to increase or even maintain its early production. While it turns out more of the articles it continues to make, the products of the factory are not so varied now as they were many years ago.

The property owners and the moneyed men of California have, in times past, been inconsiderately blamed for their lack of enterprise. How little ground there has been for such complaint the history of our domestic industries discloses. Looking back, it is seen that this class of citizens, instead of a lack, have displayed rather an excess of public spirit; millions of dollars having been sunk by them in the vain endeavor to establish in this State a variety of industries prematurely. Hardly a single branch of business can be named but has here its representative in more than one dead failure. True, some of these enterprises have since been resuscitated, and are now on a permanent and prosperous footing. But a greater number have suffered final collapse, with a loss to investors of all the money they ever put in them, and sometimes more besides.

The San Francisco and Pacific Company employs at the present time about one hundred and thirty hands, nearly equally divided between men and boys. Ten years ago they ran two furnaces, now only one, with six pots. Last year they had work for thirty-three glass blowers, this year for only twenty-seven. They make only what is denominated green glass; such as common bottles, druggists' and liquor dealers' wares, fruit jars, carboys, demijohns, etc. Of demijohns, they manufacture one hundred and twenty thousand pieces annually, being about 80 per cent of the number used on this coast. They obtain their sand from Monterey. Formerly, the various companies experimented with sand procured from the neigh-

borhood of Oakland, and even in some instances from the seashore and the sand dunes near San Francisco, but this all proved too impure for even the most common uses.

IMPORTATIONS OF GLASS INTO CALIFORNIA.

The progress that should have been made in the business of glass making in this State has been kept in check through a variety of causes, the chief of these being excessive importations from the Eastern States and Europe; imports from the former having been greatly stimulated of late years through cheap railroad transportation. The total value of this class of goods brought here in 1889 amounted to $2,338,414, divided as follows: $1,528,600 from States east of the Rocky Mountains, and $809,814 from Europe. The imports from the latter consisted of window glass, valued at $63,320; plate glass, $129,079; bottles, demijohns, carboys, etc., $131,826; tableware and medicines, $139,589. From the Eastern States, window glass, $110,000; rough plate, fluted and rolled glass, $16,800; plate glass, $70,000; bottles, demijohns, carboys, etc., $1,000,000; tableware, medicines, colored bottles, etc., $300,000; colored glass, $16,800; bull's-eye insulators, $15,000. The above figures include invoice price, packing, freight, duty, insurance, and exchange; the invoice price amounting to $1,365,092, and the other items to $973,322. For making this quantity of glasswares seven thousand tons of sand would be required. Of the freight money paid on goods shipped here from other States of the Union, two thirds, equal to $341,734, went to eastern corporations. The window glass alone imported into San Francisco during the past two years amounted to eighteen million two hundred and sixteen thousand six hundred and eighty-three pounds, valued at $278,042.

WHY WE HAVE NOT BEEN ABLE IN THIS LINE OF GOODS TO COMPETE WITH MANUFACTURERS ABROAD.

Reviewing the history of glass making in California, the question arises, how comes it that we have not been able ourselves to supply the home demand for articles in this line to a greater extent than we have done? It would seem at first glance as if, with a considerable duty imposed on the foreign importation, and freights on goods of eastern manufacture working in our favor, we could have supplied ourselves with glasswares of the more cheap and bulky kind at least, which, as shown, we have failed to do.

But the answer to this question is ready: it lies in the fact that nearly all the factors of production are much dearer here than in manufacturing countries abroad. Labor, the principal element, is with us from 50 to 60 per cent dearer than in the Eastern States, and nearly twice as dear as in all parts of Europe; capital, insurance, freights, fuel, etc., being also much dearer here than in most other countries.

Again, in the matter of raw material: we have not until recently succeeded in finding on this coast a sand suitable for making glasswares other than of the cheaper and coarser kinds. A former proprietor of the San Francisco and Pacific Works undertook at one time to import sand from Belgium, but, although brought here as ballast, the experiment failed owing to the duty to which the sand was subjected.

Nor is it alone in the higher grade wares that the home manufacturer is in this respect placed at a disadvantage. Even in the making of beer bottles he cannot quite compete with the German article, the iron in our California sand making it impossible to produce here a bottle wholly acceptable

to the trade. To get rid of this iron, which would require the employment of expensive chemicals and an intense heat, would cost too much to warrant its elimination. It is claimed, too, that the imported is in some other particulars better than the home-made bottle, being smoother and seamless, and, therefore, handsomer and stronger. To correct these defects would require so much additional labor that the California manufacturer finds it expedient to turn out a cheaper and less attractive article, even though it do not meet all the requirements of the market. Our brewers, for instance, for their exported beer, which has first to be steamed, have need for a very strong bottle, stronger than those made by either the local or the foreign manufacturer. They, therefore, for this particular use, get their bottles from the East, these proving to have greater strength than any others.

When it comes to a certain class of wine makers they, too, have in this connection a grievance, real or affected, objecting to the California bottle for putting up their clarets, on the ground that it lacks that peculiar shade or tint imparted by the foreign manufacturer, and which it is alleged cannot be produced either here or elsewhere in the United States. Nearly all our vintners are, in fact, using imported wares for bottling their wines, assigning for this course reasons similar to the above, all seemingly more or less whimsical.

As, however, the eye and even the fancy has to be consulted in these matters, as well as the taste, the commercial instinct recognizes the necessity of catering to these caprices of trade, even though they have little or no foundation in reason. It behooves, then, the California manufacturer to study carefully these special requirements and minor defects of the business, addressing himself to meeting the one and curing the other as far as may be. But, after all,

THE GREAT TROUBLE IN THIS STATE—

The one insurmountable obstacle that has barred the progress of the glass-making industry—has been the absence here of a sand adapted for making the finer and higher priced goods of this kind; nor until this desideratum is supplied, can the business be much advanced beyond its present feeble and dwarfed condition.

To fill this long standing and vital want, the most strenuous endeavors have been made, much time and money having been expended to that end. The whole coast has been explored by those out on this and similar errands. Hunters after coal and other of the useful minerals, as also prospectors for the precious metals, have, while in the field, had an eye to the discovery of this almost equally precious sand, for which the glass manufacturers have always held themselves ready to pay a liberal bonus. But not until the past year have these efforts been rewarded with success, there being now no room to doubt that a very extensive bed of glass sand, and of the very best quality, has been discovered in this State.

THE NEW FIND—ITS SITE AND PROBABLE IMPORTANCE.

The deposit above alluded to is located in the western part of Placer County, near the town of Lincoln, and immediately on the line of the California and Oregon Railroad. The history of this discovery is briefly as follows: Mr. F. H. Rosenbaum, of San Francisco, for many years an importer of and large dealer in mirrors and other high grade glasswares, impressed with the importance of finding in this State a better glass sand than had

yet been met with, employed a thoroughly qualified expert, and sent him to prospect for such deposit. Having visited various parts of the State and spent many months without satisfactory results, these parties, principal and employé, repaired to the State Mining Bureau, in the hope that they might be able to there obtain some useful hints and, perhaps, helpful information. In this they were not disappointed. The Bureau had in its possession a sample of what the analytical chemist attached to that institution had tested and determined to be a good glass sand, the same having been procured from the vicinity of Lincoln.

With this clue, and much additional information calculated to further the object of this search, this expert, providing himself with suitable boring apparatus, proceeded at once to Lincoln, and there commenced boring on a tract of land adjoining the town, and known as the Pyremont Ranch.

On this tract, which comprises two hundred and forty acres, since secured by Mr. Rosenbaum, twenty-five prospecting holes were put down, the following strata having been passed through: top soil, a red loam, a pure white sand; white kaolin, yellow kaolin, fire-clay of various colors, red and blue brick-clay, lignite, with indications of harder coal beneath it.

The kaolin and the clays, which appear to extend over the entire tract, occur in strata varying from one to forty feet in thickness, and represent millions of tons. The sand, as nearly as could be determined by the borings made, reaches within the limits of the ranch one million three hundred and twenty-six thousand tons, and may amount to much more. By the same test the lignite has, over an area of one hundred and twenty acres, an average thickness of ten feet, representing two million tons at least. There is water enough on the premises for both mining and manufacturing purposes, even though prosecuted on the most extensive scale.

The mass of this sand, as shown by analysis, consists of 97.29 silica, being practically a pure article. Experts who have examined it pronounce it as good as any ever yet found. Glass of the very best quality has, in fact, been made from it. The lignite burns freely, being of the same character as the considerable quantities obtained in the neighborhood, and which has been successfully used for generating steam in the large pottery works of Gladden & McBean, at Lincoln; also in the flouring mills at Sacramento, Marysville, and elsewhere.

MAY CHANGE THE WHOLE ASPECT OF THE BUSINESS IN CALIFORNIA.

If the expert of Mr. Rosenbaum has not been mistaken in his estimates, it may be expected that a new phase will in a short time be put on the glass-making business of California, inasmuch as a good sand, and an available fuel occurring in conjunction, are enough to insure for this industry a prosperous future. A company has already been formed for the purpose of opening up these deposits, and erecting works for the manufacture of glass on the spot. That the enterprise, if properly managed, will result in a great success can hardly be doubted, as this company will be able to make that line of goods that cannot now be produced here, but which everywhere affords the largest profit. Besides, the demand for wares of this kind are destined to undergo in California large and rapid increment. The present requirements of our wine makers and our fruit growers are nothing compared with what they soon will be. At the rate our population is increasing, the general wants of the country in this line will be doubled in the course of a few years.

In the large eastern factories, where a great variety of goods are made, the workmen are confined to a single line, at which they become very

expert, performing more and doing better work than when their attention is divided among several things. A large company might adopt the same practice here, gaining thereby similar advantages, the limited number of articles we now make rendering this subdivision of labor impracticable. A new company entering the field would in fact be able to adopt all the most recent methods, processes, and appliances that have met with approval elsewhere. They could avail themselves of all prior experience, adopting at the start what might have cost their predecessors in the business a great deal to test and establish.

NEW PROPERTIES AND USES.

Then, there is no knowing what additional properties may yet be developed in glass nor the many new uses to which it may hereafter come to be applied. Every year something is evolved imparting to this substance additional value. Already glass railroad sleepers have been substituted for iron with some success, they proving to be much cheaper while they are nearly as strong as castiron. Practically they are imperishable as regards climatic changes, the influence of the atmosphere, and the ravages of insects.

For flooring, glass has come into large use, being adopted where much light is required in cellars. It costs but little more than wood, while it absorbs no impurities and is easily kept clean. A process has been perfected whereby glass can be made pliable. Though it soon parts with this property there is but little doubt but means will yet be discovered by which it can be made permanent. Mr. Frederick Siemens, of Dresden, has discovered a method whereby an unwonted degree of hardness and strength can be communicated to glass, greatly increasing its fitness for the manufacture of domestic utensils and also for building material and similar uses.

In short, the manufacturer of glass in planning for the future might presume a great deal on the chances of its undergoing heavy and important improvements, adapting it for purposes of which we can now form no conception.

MINERAL PRODUCTS OF THE UNITED STATES IN 1888.

The sixth report on the "Mineral Resources of the United States," by David T. Day, Chief of the Division of Mining Statistics and Technology, United States Geological Survey, shows the following totals of the more important mineral substances produced in this country during the year 1888:

METALS.

Iron and Steel.—The principal statistics of 1888 were: Domestic iron ore consumed, about 12,060,000 long tons; value at mines, $28,944,000. This is an increase over 1887 in quantity of 760,000 tons, but a decrease in value of $4,956,000. Imported iron ore consumed, 587,470 long tons; total iron ore consumed in 1888, about 12,650,000 long tons, or 150,000 tons more than in 1887. Pig-iron made in 1888, 6,489,738 long tons; value at furnace, $107,000,000. This is an increase over 1887 of 72,590 tons in quantity, but a decrease of $14,925,800 in value. Steel of all kinds produced in 1888, 2,899,440 long tons; value at works, $89,000,000. This is a decrease from 1887 of 439,631 tons in quantity and of $14,811,000 in value. Total spot value of all iron and steel made in 1888, in the first stage of manufacture, excluding all duplications, $145,000,000, a decrease of $26,103,000 as compared with 1887. Limestone used as a flux in the manufacture of pig iron in 1888, about 5,438,000 long tons; value at quarry, about $2,719,000.

Gold and Silver.—According to the Director of the Mint the gold product was 1,604,927 fine ounces, valued at $33,175,000. This is about the same as in 1887, being an excess of only $75,000. The silver product was 45,783,632 fine ounces, of the commercial value of about $43,000,000, and of the coining value of $59,195,000. This is an increase of 4,515,327 ounces over the product in 1887. In addition to the product of our own mines some 10,000,000 ounces of silver were extracted in the United States from foreign ores and bullion.

Copper.—The total product, including the yield of imported ores, increased to 231,270,622 pounds, or 115,635 short tons, during 1888, which is 46,053,291 pounds more than the product of 1887. During the first quarter of 1889 the production was increasing at even a more rapid rate. The prices received by American producers averaged 15¼ cents per pound for Lake copper, 14½ for Arizona, and 14 for other districts; making the total value $33,833,954. Montana led in the production, making 97,897,968 pounds. Consumption was somewhat reduced by the high prices.

Lead.—The product increased to 180,555 short tons from 160,700 tons in 1887. The increase was due principally to the heavier receipts of lead in Mexican silver-lead ores from 15,000 tons in 1887 to over 27,000 tons in 1888. The average price in New York was 4.41 cents per pound. The production of white lead, chiefly from pig lead, was 89,000 short tons, valued at $10,680,000.

Zinc.—The erection of new works and the extension of old ones led to a further notable increase in the production of zinc in 1888. The additions to capacity were fairly uniformly distributed in the West, East, and South.

Production in 1888, 55,903 short tons, with a total value of $5,500,855; in 1887, 50,340 tons, worth $4,782,300. The production of zinc white in 1888, directly from ores, was 20,000 short tons, worth $1,600,000.

Quicksilver.—The product was 33,250 flasks (of 76½ pounds each) from California, a decline in that State of 510 flasks from 1887 in spite of a very satisfactory price, which averaged $42 50 per flask, making the total value $1,413,125. No new valuable deposits were discovered in 1888, and without them it is not probable that the yield of quicksilver will increase.

Nickel.—The industry remains unchanged except for indications of further developments at Lovelocks, in Nevada, and Riddle, Oregon. The product includes 190,637 pounds of metallic nickel, valued at $114,382, at 60 cents per pound, and 4,545 pounds, worth $1,136, exported in ores and matte. Total value, $115,518. The corresponding value in 1887 was $133,200.

Cobalt Oxide.—The total product, including the contents of the exported ores and matte, was 12,266 pounds, worth $18,441. In 1887 the total was 18,340 pounds, worth $18,774, the lower rate of value in that year resulting from a larger proportion of exported nickel in matte and ore. The price of cobalt oxide remained at $2 per pound.

Chromium.—The product declined from 3,000 tons in 1887 to 1,500 tons in 1888. The average price in San Francisco remained $15 per ton. Increased operations are probable in 1889.

Manganese.—The product of manganese and manganiferous iron ores in the United States in 1888 was 239,460 tons, valued at $876,215. Of this amount some 25,500 tons would be classed as manganese ores; the remainder as manganiferous iron ores. Of the manganiferous iron ores, 11,462 tons, averaging 11 per cent of manganese, and 189,574 tons, averaging 4 per cent of manganese, were from the Colby Mine, Michigan. In addition to the above, some 60,000 tons of argentiferous manganese ores, valued at $10 a ton, chiefly for the silver contained in them, were produced in the Rocky Mountain region.

Aluminum.—The past year was more promising than ever before for the production of cheap aluminum. The production of metallic aluminum as an industry distinct from the production of alloys began toward the close of the year, and 500 pounds had been made up to December 31; the production of 3,000 pounds since then indicates that the industry may continue. The exact amount of alloys produced by the Cowles process has not been furnished, but was not markedly different from the product of 1887, when 18,000 pounds of aluminum contained in bronze and ferro-aluminum were produced. The price for metallic aluminum declined to as low as $4 50 per pound for less favored brands.

Platinum.—Including the platinum and iridium separated from gold by the assay offices, and that saved in placer gold mining, the product was about 500 ounces, valued at $2,000.

FUELS.

Coal.—The total production of all kinds of commercial coal in 1888 was 142,037,735 short tons (increase over 1887, 18,022,480 tons), valued at the mines at $204,221,990 (increase, $30,625,994). This may be divided into Pennsylvania anthracite 43,922,897 short tons (increase, 4,416,642 short tons), or 39,216,872 long tons, including 38,145,718 long tons shipped by the railroads and canals and reported by their statistician, Mr. John H. Jones, and 1,071,154 long tons sold to the local trade at the mines (increase, 3,943,430 long tons), valued at $85,649,649 (increase, $6,284,405); all other

coals, including bituminous, brown coal, lignite, small lots of anthracite produced in Colorado and Arkansas, and 4,000 tons of graphitic coal mined in Rhode Island, amounting in the aggregate to 98,114,838 short tons (increase, 13,605,838 tons), valued at $118,572,341 (increase, $24,341,589). The collier consumption at the individual mines varies from nothing to 8 per cent of the total output of the mines, being greatest at special Pennsylvania anthracite mines and lowest at those bituminous mines where the coal bed lies nearly horizontal, and where no steam power or ventilating furnaces are used. The averages for the different States varies from 2 to 6.4 per cent, the minimum average being in the Pennsylvania bituminous and the maximum average being in the Pennsylvania anthracite region. The total output of the mines, including colliery consumption, was: Pennsylvania anthracite, 41,624,610 long tons (increase over 1887, 4,045,-863 long tons), or 46,619,564 short tons (increase, 4,531,367 short tons); all other coals, 102,039,838 short tons (increase, 14,152,478 tons), making the total output of all coals from mines in the United States, exclusive of slack coal thrown on the dumps, 148,659,402 short tons (increase, 18,683,-845 tons), valued as follows: Anthracite, $89,020,483 (increase, $4,468,302); bituminous, $122,497,341 (increase, $24,492,685); total value, $211,517,-824 (increase, $28,960,987). The above figures show a notable increase in 1888 over 1887 in the aggregate output and value of both anthracite and bituminous coal, although not as great an increase as occurred in 1887 over 1886 in the value of the anthracite, or in the total tonnage of the bituminous coal.

Coke.—The production of coke in the United States in 1888 was 8,527,-560 tons, valued at about $14,000,000. Pennsylvania produced by far the largest amount, the Connellsville region alone producing 4,952,553 tons; West Virginia, 528,533 tons; Alabama, 518,511 tons; Tennessee, 385,693 tons, and Virginia, 149,099 tons.

Petroleum.—The product of petroleum in the United States in 1888 was 27,346,018 barrels (of 42 gallons each), valued at about $24,598,559. Of this amount Pennsylvania produced 16,491,083 barrels; Ohio, 10,010,868 barrels; West Virginia, 119,448 barrels; California, 704,619 barrels; and other States, 20,000 barrels.

Natural Gas.—The amount of natural gas consumed is given in coal displacement; that is, the amount of coal displaced by the use of natural gas. It is estimated that the amount of coal displaced by natural gas in the United States in 1888 was 14,163,830 tons, valued at $22,662,128. Of this amount 12,543,830 tons were displaced in Pennsylvania; 750,000 tons in Ohio, and 660,000 tons in Indiana.

STRUCTURAL MATERIALS.

Building Stone.—Direct returns from producers of the various kinds of building stone show that there was but a small gain in value over the figures of 1887. The value of the stone produced in 1888 is $25,500,000, or $500,000 more than in the preceding year.

Brick and Tile.—Value $48,213,000. This figure represents only a small gain over 1887. This is due rather to increase in the number of manufacturing plants than to increased production at the older and more important sources of supply; in fact, many of the latter show a falling off in production. Prices also were generally somewhat lower than in 1887.

Lime.—The production is estimated at 49,087,000 barrels, with an average value of 50 cents per barrel, making a total of $24,543,500 as the value of the year's product. These figures are not largely in advance of those

for 1887, and the gains are not so much the results of increased production in the leading lime regions as in localities of minor importance.

Cement.—The amount of cement produced in 1888 is less than for 1887, being 6,253,295 barrels for 1888, valued at 72½ cents per barrel, making $4,533,639 as the value of the year's product.

ABRASIVE MATERIALS.

Buhrstones.—The product which is used for grinding cement, plaster, paints, feed, etc., comes from New York, Pennsylvania, and North Carolina, and is valued at $150,000.

Grindstones.—Ohio and Michigan furnish practically all the sandstone from which grindstones are made. The product in 1888 increased slightly, 41,000 long tons, worth $281,800, being produced, against 37,400, worth $224,400, in 1887. The price varied from $6 50 to $10 per ton at the quarries before being finished into grindstones.

Corundum.—Production is limited to the old mines in North Carolina and Georgia; 589 short tons, valued at $91,620, were produced in 1888, against 600 tons in 1887.

Oilstones and Whetstones.—The production of novaculite from Arkansas increased slightly, making the total, including Labrador oilstone, etc., 1,500,000 pounds, valued at $18,000 in the rough state.

MISCELLANEOUS.

Precious Stones.—No systematic mining was carried on in search of gems in 1888. But in mining for other substances, and in chance discoveries, gems worth $64,850 in the rough state, and gold quartz worth $75,000, were found.

Phosphate Rock.—The production declined to 433,705 long tons, but the total value increased slightly to $1,951,673 on account of better prices. The trade in manufactured fertilizers was very prosperous.

Marls.—The production in the Southern States, particularly in Virginia, North Carolina, Alabama, Mississippi, and Florida, is increasing, while the product of New Jersey did not vary from 1887. About 600,000 tons, valued at $300,000, were produced.

Salt.—The industry shows only slight changes: In 1888, the production was 8,055,881 barrels of 280 pounds, valued at $4,377,204. In 1887, the product was 8,003,962 barrels, worth $4,093,846. Kansas became a commercial source of salt in 1888, producing 155,000 barrels, with a prospect of still greater increase in 1889.

Bromine.—The product was 307,386 pounds, worth $95,290, an increase from 199,087 pounds in 1887, worth $61,717. The price remained at 31 cents per pound.

Borax.—The production was restricted to 7,589,000 pounds, worth $455,340, at 6 cents per pound for the average quality. In 1887 the product was 11,000,000 pounds, worth 5 cents per pound.

Sulphur.—The sulphur refinery in Utah was partially burned. This and litigation over the property prevented any production in 1888. The supply came principally from Sicily, with small importations from Japan. It was practically all made into sulphuric acid.

Pyrites.—Production 54,331 long tons, valued at the mines at $167,658; a slight increase in quantity over the previous year.

Barytes.—The production from Missouri, Virginia, and New York in-

creased to 20,000 long tons, worth at the mines $110,000. In 1887 the product was 15,000 long tons, worth $75,000.

Gypsum.—The domestic supply comes principally from Ohio and Michigan, with smaller amounts from New York, Virginia, Kansas, Colorado, California, Dakota, and Utah. The product in 1888 was 96,000 short tons of crude gypsum, valued at $430,000. A large portion of the supply is imported from Nova Scotia, where 126,118 tons, worth $121,579, were produced in 1888.

Ozocerite.—From the region of Soldier's Summit, Utah, about 20,000 pounds of crude mineral wax were produced, worth $1,000 in New York, where the material was sold. An increase is probable in 1889.

Soapstone.—Production, about 15,000 tons, worth $50,000 before shipment.

Asphaltum.—The product of 1888 includes 700 tons of gilsonite, mined in Utah; 3,100 tons of ordinary asphaltum, principally from California; and 50,000 tons of bituminous rock, quarried in California for pavements in competition with asphaltum. Total value, $331,500.

Feldspar.—The consumption for potters' use declined to 8,700 long tons, worth, in Trenton, New Jersey, $50,000. In 1887 10,200 long tons were produced, worth $56,100.

Flint.—For potters' use the consumption was 16,250 long tons. Including that for sandpaper and for glass, the consumption was about 30,000 tons, worth, underground, $175,000.

Potters' Clay.—The consumption included 18,000 long tons of kaolin or china clay, 5,250 tons of ball clay, and 13,500 tons of fire clay, worth altogether $300,000.

Mica.—Owing principally to the use of smaller sizes in stoves, the production of sheet mica decreased from 70,500 pounds in 1887 to 48,000 in 1888, valued at $70,000. There is increased demand for mica waste.

Mineral Paints.—The product, including ocher, metallic paints, and small amounts of umber and sienna, increased to 24,000 long tons, valued at $380,000.

Graphite.—The production of pure graphite was limited to Ticonderoga, New York, and is reported as unchanged. The total production of pure material was 400,000 pounds, worth $33,000. Small amounts of less pure material, for foundry facings, etc., were produced in North Carolina, and at Cranston, Rhode Island.

Fluorspar.—The production, limited to the neighborhood of Roseclare, Illinois, and Evansville, Indiana, is reported at 6,000 tons, worth $30,000, an increase of 1,000 tons over 1887.

Infusorial Earth.—The product came principally from Maryland, and amounted to 2,500 short tons, worth, before shipment, $12,500.

Zircon.—During 1887 and 1888, 25 tons of zircon were mined, principally in Henderson County, North Carolina, and sold for $10,000 for the manufacture of incandescent gas burners. About 4 tons of monazite, one ton of allanite, 600 pounds of samarskite, and $500 worth of yttrium minerals were produced for the same use. About 6 tons of monazite and 5 tons of cerite were also imported.

Mineral Waters.—Amount sold in 1888, 9,628,568 gallons, valued at $1,709,302. In 1887 the product was 8,259,609 gallons, worth $1,261,473.

METALLIC PRODUCTS OF THE UNITED STATES IN 1888.

	Quantity.	Value.
Pig iron, spot value, long tons	6,489,738	$107,000,000
Silver, coining value, troy ounces	45,783,632	59,195,000
Gold, coining value, troy ounces	1,604,927	33,175,000
Copper, value at New York City, pounds	231,270,622	33,833,954
Lead, value at New York City, short tons	180,555	15,924,951
Zinc, value at New York City, short tons	55,903	5,500,855
Quicksilver, value at San Francisco, flasks	33,250	1,413,125
Nickel, value at Philadelphia, pounds	195,182	115,518
Aluminum, value at Philadelphia, pounds	19,000	65,000
Antimony, value at San Francisco, short tons	100	20,000
Platinum, value (crude) at New York City, troy ounces	500	2,000
Total	....	$256,245,403

NON-METALLIC MINERAL PRODUCTS OF THE UNITED STATES IN 1888 (SPOT VALUES).

	Quantity.	Value.
Bituminous coal, long tons	91,106,998	$122,497,341
Pennsylvania anthracite, long tons	41,624,610	89,020,483
Building stone	....	25,500,000
Lime, barrels	49,087,000	24,543,500
Petroleum, barrels	27,346,018	24,598,559
Natural gas	....	22,662,128
Cement, barrels	6,253,295	4,533,639
Salt, barrels	8,055,881	4,377,204
Limestone for iron flux, long tons	5,438,000	2,719,000
South Carolina phosphate rock, long tons	433,705	1,951,673
Zinc white, short tons	20,000	1,600,000
Mineral waters, gallons sold	9,628,568	1,709,302
Borax, pounds	7,589,000	455,340
Gypsum, short tons	96,000	430,000
Manganese ore, long tons	25,500	255,000
Mineral paints, long tons	24,000	380,000
New Jersey marls, short tons	600,000	300,000
Pyrites, long tons	54,331	167,658
Flint, long tons	30,000	175,000
Mica, pounds	48,000	70,000
Corundum, short tons	589	91,620
Sulphur, short tons	....	....
Precious stones	....	64,850
Gold quartz, souvenirs, jewelry, etc	....	75,000
Crude barytes, long tons	20,000	110,000
Bromine, pounds	307,386	95,290
Feldspar, long tons	8,700	50,000
Chrome iron ore, long tons	1,500	20,000
Graphite, pounds	400,000	33,000
Fluorspar, short tons	6,000	30,000
Slate ground as pigment, long tons	2,500	25,000
Cobalt oxide, pounds	12,266	18,441
Novaculite, pounds	1,500,000	18,000
Asphaltum, short tons	53,800	331,500
Asbestus, short tons	100	3,000
Rutile, pounds	1,000	3,000
Total	....	$328,914,528

Recapitulating the items contained in the above table, the value of the minerals produced in the United States in 1888 was as follows:

Metals	$256,245,403
Mineral substances	328,914,528
	$585,159,931
Estimated value of mineral products unspecified	6,500,000
Grand total	$591,659,931

The mineral product of 1888 shows an increase of nearly fifty millions over that of 1887, which was the largest by $77,000,000 of any made in the history of the country. The large product of 1888 was due in part to the high price of copper, which increased it to the extent of $13,000,000 above what it would have been had that industry remained in a normal condition. This increment was, however, partially counteracted by the decline in the total value of pig iron. The other leading factors of increase consisted mainly of coal and other fuels concerned in the production of mineral substances.

GOLD AND SILVER.

Adopting the figures given by the Director of the Mint, this report makes the total commercial value of the gold and silver produced in the United States for the year only about $76,000,000, which figures are probably not much out of the way. The bullion output of the Pacific States and Territories, for the year, was by local statisticians returned at $114,341,592, but nearly one quarter of this, as stated elsewhere in this volume, consisted not of the precious metals, but of copper and lead. In addition to the silver produced by our own mines, some ten million ounces of that metal were extracted from foreign ores and bullion imported into this country, the greatest portion coming from Mexico. From the more liberal policy likely to be adopted by our Government in regard to this metal, it may be expected that silver mining will undergo early improvement on this coast. It has, in fact, already done so in so far as the prices of the white metal are concerned, figures having advanced from 92 cents per ounce, early in the year, to 96 cents, present quotations on the New York market. The fear of a glut of silver is disappearing since it became evident that it is the product of gold that is making the more rapid advance, when the whole field of production is taken into consideration. Looking to the future, there is more reason to apprehend a scarcity of silver than of gold, the productive sources of the latter being multiplied and expanded at much the more rapid rate. The Comstock Lode is turning out at present nearly as much gold as silver, nor is there much prospect of the present relations here maintained between the two metals undergoing early change. In California the product of silver has for several years past been growing less, while that of gold has been on the increase. Looking abroad it will be observed that the output of gold is everywhere being enlarged, while that of silver is standing still. Australia, Siberia, South and Central America, Africa, and India are all growing gold producers, but they turn out very little silver.

COPPER.

The enormous copper output of 1888 has, during the current year, suffered considerable curtailment, the reduction being estimated by the most intelligent authorities at 12 to 15 per cent, a result due partly to lower prices and partly to incidental causes, such as the fire at the Anaconda Mine, unexpected delays in completing California plants, etc. The price of copper, which throughout 1888 had averaged about 16 cents per pound, *began, early* in the present year, to show signs of weakening, and, declining

slightly towards the end of the first quarter, reached its minimum, $10\frac{3}{4}$ cents, early in the month of September, soon after which the market took an upward turn, and has since been steadily growing stronger, the price of Lake being quoted December twentieth at 14 cents per pound on the New York market. While this advance may have been due in part to the concerted action of large holders in manipulating the market, there can be no doubt but that the supply on hand has become much reduced, many of the smelters even being comparatively bare of stock. While the present price will tend to stimulate production, there is not much danger that it will greatly exceed consumption, at least for some time to come, as the demand for this metal, while it keeps pace with the growth of all other industries the world over, is likely to be further increased by several new uses to which it is about being put. If the German Government should employ the new powder, as talked of, the requirements for manufacturing cartridges will absorb a large amount of the European product of copper. The large stock of this metal originally held by the French syndicate, and the disposal of which so upset the market last spring, has been reduced to the extent of sixty thousand tons during the last eight months, leaving in the hands of that institution a balance so inconsiderable that it can no longer exercise a controlling influence.

LEAD.

As with copper, so has there also been some falling off in our domestic production of lead the present year, though the decline in this instance has not been so marked, nor has it extended to so many lead-producing localities—Idaho, Nevada, and Montana being the countries most involved in this reduction. As for Nevada, its entire output has not amounted to one hundred tons for the year, against several thousand tons turned out only a few years ago. California, never a large producer of lead, has made none whatever for some time past, though it is now probably on the eve of regaining its status in this respect through the reopening and active working of the Cerro Gordo Mines, Inyo County, where alone has any considerable quantity of lead ever been produced in this State. The small amounts of lead-silver bullion turned out of late in Nevada and Arizona have gone east, the former to Salt Lake and the latter to smelters in Colorado and New Mexico for parting and refining.

QUICKSILVER.

The California product of this metal—thirty-three thousand two hundred and fifty flasks in 1888—did not probably exceed thirty thousand flasks the present year, and this, notwithstanding the price has been meantime steadily advancing. It is the case, too, that operations have during the year been resumed on several deposits of cinnabar, that had been opened and equipped with plant some time ago, but on which work was suspended on the occurrence of extreme low prices.

The Gypsy Mine, located in Lone Tree District, San Benito County, has within the last few months been brought into production, turning out since about thirty flasks of metal per month. Efforts made last summer to reopen and work the Altoona Mine, Trinity County, having been defeated, by reason of disputed title, that valuable property remains idle, although known to contain a large body of high grade ore. Quicksilver, worth at the opening of the year, 54 cents per pound, has since advanced to 63 cents, the price at which it is now quoted on the New York market. That

production has failed to respond to this advance in the price of the metal finds explanation in the fact that owners deem it expedient to husband the resources of their mines, which, through an overestimate of their extent, were at one time being depleted at a ruinously rapid rate. The ore of this metal being restricted to a few countries, and to a limited area in each, suggests economy in disposing of it, wherefore no great overproduction of quicksilver is likely to occur hereafter. If enough be turned out to meet the growing requirements of consumption this is all that can be expected in the future.

BORAX.

The product of this salt for the current year amounted to seven million six hundred thousand pounds against seven million five hundred and eighty-nine thousand pounds in 1888; the output having been, as for the preceding two years, somewhat restricted through concerted action of producers; price slightly higher than last year, average 7½ cents per pound, 7 for concentrated, 7½ for powdered and refined, these being car and cargo rates. Of the borax crop of the United States about 70 per cent is made in California, the remainder in Nevada. About the middle of the year a new company operating in Saline Valley, Inyo County, began making borax, and have since turned out the refined article at the rate of about forty tons per month. A rich deposit of the borate of lime was discovered during the year immediately on the seashore in the southwestern corner of Oregon. Being conveniently located for shipment, this material is to be taken to East Oakland for reduction, works having been there erected for the purpose.

PETROLEUM.

Statistician Day credits California with an oil production of eight million seven hundred and nineteen thousand nine hundred and ninety-eight gallons for the year 1888, a quantity that has since been increased to nine million gallons, or a little more. The oil industry of this State is in a healthy condition, being on a good basis, and making some progress every year. The Pacific Oil Company, the largest operator in the field, has bored four new wells during the present year, all of which are active producers, the wells previously sunk by them also continuing to yield with but little diminution. This company has always four or five wells in process of sinking, these new contributors more than keeping good their supply. The company's two refineries have been running steadily throughout the year; the larger, located at Alameda Point, has been run to its full capacity, and made a heavy output of the refined article. With the other large company, the Mission Transfer, this has also been an active year; some new wells having been bored, and their usual complement of the crude material produced. Outside the territory of these two companies several new wells have been put down, some of which are now yielding oil. But, with all this increase, our California wells come far short of meeting local requirements, the importations of manufactured petroleum into the State being still very large. There should be more wells put down here; the present flow hardly suffices to keep our refineries constantly busy.

Boring for natural gas, a business confined mostly to the neighborhood of Stockton, has met with some success during the year. The issue from one of the wells bored there to a depth of one thousand one hundred feet has, for several months past, equaled twenty thousand cubic feet of gas per twenty-four hours.

Of our other and less important mineral products alluded to in the above report, it may be observed that, owing to the shortness of the evaporating season, the product of California salt has been less by several thousand tons this year than last; so, also, has the output of chromium, by reason of low prices, been somewhat less. Of manganese, used in ore reduction, about one hundred tons have been mined. The output of coal, cement, gypsum, antimony, asbestus, etc., never large, has been slightly increased, while of building stone much more has been quarried than ever before.

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